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**UTILITY
PATENT APPLICATION
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. MTP-023DV2

First Named Inventor Keesee et al.

Title METHODS FOR THE DETECTION OF
CANCER

APPLICATION ELEMENTS

ADDRESS TO: **Box Patent Application**
Assistant Commissioner for Patents
Washington, D.C. 20231

1. ☒ Fee Transmittal Form

2. ☒ Specification and Drawings [Total Pages 92]
- Specification - (82 pages)
- Claims - (7 pages)
- Abstract - (1 page)
- Sheets of Drawings - (2 sheets)

☐ Formal
☒ Informal

3. ☒ Oath or Declaration [Total Pages 5]
a. ☐ Newly executed (original)
b. ☒ Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)
[Note Box 4 below]

4. ☒ Incorporation by Reference (usable if Box 3b is checked)
The entire Disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 3b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

5. ☐ Microfiche Computer Program (Appendix)

6. ☒ Nucleotide and/or Amino Acid Sequence Submission
☒ Computer Readable Copy
☒ Paper Copy (identical to computer copy)
☒ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ 37 CFR 3.73(b) Statement (when there is an assignee)
☐ Power of Attorney

8. ☐ English Translation Document (if applicable)

9. ☒ Information Disclosure Statement (IDS)/PTO-1449
☒ Copies of IDS Citations

10. ☒ Preliminary Amendment
☐ Drawings [Total Sheets]
☐ Letter to Official Draftsperson Including Drawings [Total Pages]

11. ☒ Return Receipt Postcard

12. ☐ Small Entity Statement(s)
☐ Statements filed in prior application, (Status still proper and desired)

13. ☐ Certified Copy of Priority Document(s)

14. ☐ Deletion of Inventor(s)
Signed statement attached deleting inventor(s) named in the prior application.

15. ☒ Patent Application Data Entry Form

16. ☐ Other:

17. ☒ If a **CONTINUING APPLICATION**, check appropriate box and supply the requisite information:
☐ Continuation ☒ Divisional ☐ Continuation-in-part (CIP) of prior application U.S. Serial No. 08/989,045, filed December 11, 1997, which is a divisional of U.S. Serial No. 08/705,660, filed August 30, 1996.

Priority to the above application(s) is claimed under 35 U.S.C. 120.

Prior application information: Examiner: Reeves, J. Group/Art Unit: 1642.

18. ☐ **Priority - 35 U.S.C. 119**

☐ Priority of application Serial No. _____ filed on _____ in _____ is claimed under 35 U.S.C. 119.
☐ The certified copy has been filed in prior U.S. application Serial No. _____ / _____ on _____.
☐ The certified copy will follow.

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Correspondence Information

Correspondence Customer Number :: 021323

Application Information

Title Line One :: METHODS FOR THE DETECTION OF
Title Line Two :: CERVICAL CANCER
Total Drawing Sheets :: 2
Formal Drawings :: N
Application Type :: Utility
Docket Number :: MTP-023DV2
Licensed - U S Government Agency ::
Contract Number ::
Grant Number ::
Secrecy Order in Parent Application ::

Representative Information

Representative Customer Number :: 021323

Continuity Information

This application is a :: Continuation of
>Application One :: 08/989,045
Filing Date :: December 11, 1997
Patent Number ::
which is a :: Divisional of
>>Application Two :: 08/705,660
Filing Date :: August 30, 1996
Patent Number :: U.S. Patent No. 5,858,683

Prior Foreign Applications

Foreign Application One ::
Filing Date ::
Country ::
Priority Claimed ::

293DAG8395/27.793494-1

PATENT
Atty. Docket No.: MTP-023DV2
(8395/27)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

SERIAL NO.: _____ (*Divisional of U.S.S.N. 08/989,045*)
FILED: *Herewith*
TITLE: *METHODS FOR THE DETECTION OF CERVICAL CANCER*
GROUP NO.: 1642
(Prior Application)
EXAMINER: J. Reeves
(Prior Application)

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

This application is a divisional of U.S. Serial No. 08/989,045, filed December 11, 1997, which itself is a divisional of U.S. Serial No. 08/705,660, filed August 30, 1996.

Prior to substantive examination, please amend the application as follows:

In the Specification:

On page 1, immediately after the title and before the title "Field of the Invention," insert the following text:

-- Reference to Related Applications

This application is a divisional of USSN 08/989,045, filed December 11, 1997, which is a divisional of USSN 08/705,660, filed August 30, 1996, now US Patent No. 5,858,683. --

In the Claims:

Cancel claims 1-23 and 28-38, without prejudice to their subsequent reintroduction into this case, or their introduction into a subsequently filed continuation application.

REMARKS

This application is a divisional of U.S. Serial No. 08/989,045.

Applicants have amended the specification to include a priority claim. Furthermore, Applicants have canceled claims 1-23 and 28-38 without prejudice. Following entry of this amendment, claims 24-27 will be pending in the instant application.

In a requirement for restriction issued March 14, 1997 in grandparent application USSN 08/705,660, claims 24-27 were designated as belonging to Group II (method of detecting cervical cancer by detecting DNA, allegedly classified in class 435, subclass 6). This application has been filed to pursue the subject matter of class II.

Applicants believe that the aforementioned amendments introduce no new matter. In addition, Applicants believe that no additional claim fee is incurred by the submission of this paper.

Early favorable action is respectfully solicited.

Respectfully submitted,



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APPLICATION

FOR

UNITED STATES

LETTERS PATENT

SPECIFICATION

(For Attorney Docket No. MTP-023)

TO ALL WHOM IT MAY CONCERN:

Be it known that we, Susan K. Keesee, Robert Obar and Ying-Jye Wu, citizens of the United States of America, residing at of P.O. Box 692, 87 Oak Hill Road, Harvard, MA, 19 Lewis Avenue, Walpole, MA; and 71 Flanagan Drive, Framingham, MA, respectively in the United States of America, have invented new and useful improvements in

“METHODS AND COMPOSITIONS FOR THE DETECTION OF CERVICAL CANCER”

of which the following is a specification.

**METHODS AND COMPOSITIONS FOR THE
DETECTION OF CERVICAL CANCER**

Field of the Invention.

The present invention relates generally to methods and compositions for the detection of cervical cancer. More specifically, the present invention relates to cervical cancer-associated proteins which act as cellular markers useful (i) in detecting cervical cancer, and (ii) as molecular targets for cervical cancer therapy.

Background of the Invention.

Cancer of the uterine cervix is one of the most common malignancies in women and remains a significant public health problem throughout the world. In the United States alone, invasive cervical cancer accounts for approximately 19% of all gynecological cancers (Miller *et al.* (1993) in "Surveillance Epidemiology, and End Results Program cancer Statistics Review: 1973-1990", NIH Pub. No. 93-2789, Bethesda, MD: National Cancer Institute). In 1996, it is estimated that there will be 14,700 newly diagnosed cases and 4900 deaths attributed to this disease (American Cancer Society, Cancer Facts & Figures 1996, Atlanta, GA: American Cancer Society, 1996). In many developing countries, where mass screening programs are not widely available, the clinical problem is more serious. Worldwide, the number of new cases is estimated to be 471,000 with a 4 year survival rate of 40% (Munoz *et al.* (1989) "Epidemiology of Cervical Cancer" in "Human Papillomavirus", New York, Oxford Press, pp 9-39; and National Institutes of Health, Consensus Development Conference Statement on Cervical Cancer, April 1-3, 1996).

The precursor to cervical cancer is dysplasia, also known in the art as cervical intraepithelial neoplasia (CIN) or squamous intraepithelial lesions (SIL) (Brinton *et al.* (1992) “*Epidemiology of Cervical Cancer: Overview*” in “*The Epidemiology of Cervical Cancer and Human Papillomavirus*”, Lyon, France: International Agency for Research on Cancer; and Tabbara *et al.* (1992) “*The Bethesda classification for squamous intraepithelial lesions: histologic, cytologic and viral correlates*”, *Obstet. Gynecol.* **79**: 338-346). While it is not understood how normal cells become transformed, the concept of a continuous spectrum of histopathological change from normal, stratified epithelium through CIN to invasive cancer has been widely accepted for many years (*see, for example*, Mitchell *et al.* (1994) “*The natural history of cervical intraepithelial neoplasia: an argument of intermediate endpoint biomarkers*”, *Cancer Epidemiol. Biomark. Prev.* **3**: 619-626). A large body of epidemiological and molecular biological evidence has been gathered that establishes human papillomavirus (HPV) infection as a causative factor in cervical cancer (Munoz *et al.* (1992) in “*The Epidemiology of Human Papillomavirus and Cervical Cancer*”, IRAC publication no. 119, Lyon France: Int. Agency for Research on Cancer, pp 251-261). HPV is found in 85% or more of squamous cell invasive lesions, which represent the most common histologic type seen in cervical carcinoma (Cox *et al.* (1995) *Bailliere's Clin. Obstet Gynaecol.* **9**: 1-37). Additional cofactors include, for example, oncogenes activated by point mutations, and chromosomal translocations or deletions (Spandidos *et al.* (1989) *J. Pathol.* **157**: 1-10).

Cytological examination of Papanicolaou-stained cervical smears (also referred to as Pap smears) currently is the method of choice for detecting cervical cancer. Despite the historical success of this test, concerns have arisen regarding its ability to predict reliably the behavior of same preinvasive lesions (Ostor *et al.* (1993) *Int. J. Gynecol. Pathol.* **12**: 186-192; and Genest *et al.* (1993) *Human Pathol.* **24**: 730-736). The identification of a cervical cancer-associated tumor marker for reliably detecting early onset of cervical cancer and/or providing early prognostic information will greatly aid the management of cervical cancer.

All eukaryotic cells have a nucleus containing DNA, or chromatin, which is organized by an internal protein scaffolding known as the nuclear matrix (NM). The nuclear matrix was first

described in 1974 by Berezney *et al.* (Berezney *et al.* (1974) *Biochem. Biophys. Res. Commun.*,
60: 1410-1417). Penman *et al.* describe a method for selectively extracting insoluble interior
nuclear matrix proteins and their associated nucleic acids from cells and determining the
particular cell type by analyzing the proteins by two-dimensional gel electrophoresis (see for
example, U.S. Pat. Nos. 4,882,268, issued 11/21/89, and 4,885,236, issued 12/5/89, the
disclosures of which are incorporated herein by reference).

The nuclear matrix is believed to be involved in a wide variety of nuclear functions
fundamental to the control of gene expression. For a general review see, for example, Fey *et al.*
(1991) *Crit. Rev. Euk. Gene Express.* 1: 127-143. Tissue-specific nuclear matrix proteins have
been identified in the rat, mouse and human. Fey *et al.* (1986) *Proc. Natl. Acad. Sci. USA* 85:
121-125; Stuurman *et al.* (1990) *J. Biol. Chem.* 265: 5460-5465; and Getzenberg *et al.* (1990)
Mol. Endocrinol. 4: 1336-1342. Changes in the presence or absence of specific nuclear matrix
proteins have been associated with cellular transformation and differentiation (Bidwell *et al.*
(1993) *Proc. Natl. Acad. Sci. USA* 90: 3162-3166; Brancolini *et al.* (1991) *Proc. Natl. Acad.*
Sci. USA 88: 6936-6940; and Greenfield *et al.* (1991) *Proc. Natl. Acad. Sci. USA* 88: 11217-
11221).

Several recent studies using similar methodology have identified tumor-specific nuclear
matrix proteins in cancers of the prostate (Partin *et al.* (1993) *Cancer Res.* 53: 744-746), breast
(Khanuja *et al.* (1993) *Cancer Res.* 53: 3394-3398), colon cancer (Keesee *et al.* (1994) *Proc.*
Natl. Acad. Sci. USA 91: 1913-1916), bone (Bidwell *et al.* (1994) *Cancer Res.* 54: 28-32),
bladder (Getzenberg *et al.* (1996) *Cancer Res.* 56: 690-694) and the larynx (Donat *et al.* (1996)
Otolaryngol. Head Neck Surg. 114: 387-393). Molecular characterization of the specific nuclear
matrix proteins, however, remains poorly defined, due to the low abundance of these proteins in
the cell and their generally insoluble character.

There is, however, a need in the art for specific, reliable markers that are expressed
differentially in normal and cancerous cervical tissue and that may be useful in the detecting
cervical cancer or in the prediction of its onset. Accordingly, it is an object of this invention to

provide cervical cancer-associated molecules which are useful as markers for the early and/or rapid detection of cervical cancers in an individual. It is another object of this invention to provide methods for detecting cervical cancers in an individual. It is another object of the invention to provide methods and compositions for treating cervical cancers in an individual and
5 for monitoring the efficacy of such a treatment in the individual.

Summary of the Invention.

The invention provides a variety of methods and compositions for detecting and/or prognosing cervical cancer in a tissue or body fluid sample of an individual. The invention is based, in part, upon the discovery of cervical cancer-associated proteins which are present at detectable levels in cervical cancer cells, but which are not detectable in normal cervical cells, as determined by two-dimensional gel electrophoresis.

In one aspect, the invention provides a method for detecting cervical cancer in a human.

The method comprises the step of detecting the presence of a cervical cancer-associated protein in a tissue or body fluid sample of the human thereby to indicate the presence of a cervical cancer or a precursor of a cervical cancer. The cervical cancer-associated protein is characterized as having a molecular weight of from about 44,900 Daltons to about 69,400 Daltons, as determined by standard polyacrylamide gel electrophoresis techniques and an isoelectric point of from about 5.1 to about 6.6 as determined by standard isoelectric focusing techniques. In addition, the cervical cancer-associated protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis. It is contemplated, however, that the accuracy and/or reliability of the method may be further enhanced by detecting the presence of a plurality of cervical cancer-associated proteins in the preselected tissue or body fluid sample.

As used herein, the term "cervical cancer" is understood to mean any cancer or cancerous lesion associated with cervical tissue or cervical cells and, in addition, includes precursors to cervical cancer, for example, dysplasia (also known in the art as a cervical intraepithelial neoplasia or a squamous intraepithelial lesion).

As used herein, the term "cervical cancer-associated" molecules refers to molecules originating from and isolatable from a cervical cancer cell or cells, and substantially neither originating from nor isolatable from a normal cervical cancer cell or cells. As used herein, the

term "cervical cancer-associated protein" is understood to mean any protein which is detectable at a higher level in cervical cancer cells than in normal cervical cells, as determined by two-dimensional (2-D) gel electrophoresis. It is not necessary that the target molecule or target protein be unique to a cervical cancer cell; rather it is preferred that the target molecule or protein has a signal to noise ration high enough to discriminate between samples originating from a cervical cancer tissue or body fluid and samples originating from normal cervical tissue or body fluid.

In a preferred embodiment, methods of the invention comprise the step of detecting one or more cervical cancer (CvC) associated proteins, referred to herein as CvC-1 through CvC-5, which can be purified or co-purified using nuclear matrix protein purification methodologies, well known and thoroughly documented in the art. See, for example, Fey *et al.* (1986) *Proc. Natl. Acad. Sci, USA* 85: 121-125, the disclosure of which is incorporated herein by reference. As used herein, the term "nuclear matrix protein" is understood to mean any non-cytoskeletal, non-lamin, non-chromatin protein that (i) is isolated from mammalian cell nuclei, (ii) is resistant to solubilization from the nuclei in 0.25M ammonium sulfate, (iii) remains in solution following dialysis into physiological buffer from 8M urea and (iv) is detectable on a silver stained two-dimensional electrophoresis gel. Accordingly, one or more of the resultant cervical cancer - associated proteins may be further defined as being a nuclear matrix protein.

In a preferred embodiment, methods of the invention may comprise the step of detecting the protein CvC-1, a protein having a molecular weight of about 69,400 Daltons, as determined by polyacrylamide gel electrophoresis, and a pI of about 5.8, as determined by isoelectric focusing techniques. Alternatively, the methods of the invention may comprise the step of detecting the protein CvC-2, a protein having a molecular weight of about 53,800 Daltons, as determined by polyacrylamide gel electrophoresis, and a pI of about 5.5, as determined by isoelectric focusing techniques. Alternatively, the methods of the invention may comprise the step of detecting the protein CvC-3, a protein having a molecular weight of about 47,900 Daltons, as determined by polyacrylamide gel electrophoresis, and a pI of about 5.6, as determined by isoelectric focusing techniques. Alternatively, the methods of the invention may

comprise the step of detecting the protein CvC-4, a protein having a molecular weight of about 46,000 Daltons, as determined by polyacrylamide gel electrophoresis, and a pI of about 5.1, as determined by isoelectric focusing techniques. Alternatively, the methods of the invention may comprise the step of detecting the protein CvC-5, a protein having a molecular weight of about 44,900 Daltons, as determined by polyacrylamide gel electrophoresis, and a pI of about 6.6, as determined by isoelectric focusing techniques.

In another preferred embodiment, the methods of the invention may comprise the step of detecting a cervical cancer-associated protein which comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 1; SEQ ID NO.: 2; SEQ ID NO.: 3; SEQ ID NO.: 4; SEQ ID NO.: 5; SEQ ID NO.: 6; SEQ ID NO.: 7; SEQ ID NO.: 8; and SEQ ID NO.: 9. Alternatively, the method of the invention may comprise the step of detecting a cervical cancer-associated protein having the amino acid sequence set forth in SEQ ID NO.: 10, commonly referred to in the art as IEF SSP 9502. See, for example, Honore *et al.* (1994) *Gene* **151**: 291-296, the disclosure of which is incorporated herein by reference.

In another preferred embodiment, the methods of the invention may comprise the step of detecting a cervical cancer-associated protein which comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 11; SEQ ID NO.: 12; SEQ ID NO.: 13; SEQ ID NO.: 14; SEQ ID NO.: 15; SEQ ID NO.: 16; and SEQ ID NO.: 17. Alternatively, the method of the invention may comprise the step of detecting a cervical cancer-associated protein having the amino acid sequence set forth in SEQ ID NO.: 18, and commonly referred to in the art as Cytokeratin 17. See, for example, Troyanovsky *et al.* (1992) *J. Biol. Biol.* **59**: 127-137, the disclosure of which is incorporated herein by reference.

In another preferred embodiment, the methods of the invention may comprise the step of detecting a cervical cancer-associated protein which comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 19; SEQ ID NO.: 20; SEQ ID NO.: 21; SEQ ID NO.: 22; SEQ ID NO.: 23; SEQ ID NO.: 24; and SEQ ID NO.: 25. Alternatively, the method of the invention may comprise the step of detecting a cervical cancer-associated protein having

the amino acid sequence set forth in SEQ ID NO.: 26, commonly referred to in the art as TDP-43. See, for example, Ou *et al.* (1995) *J. Virol.* **69**: 3584-3596, the disclosure of which is incorporated herein by reference.

5 In another preferred embodiment, the methods of the invention may comprise the step of detecting a cervical cancer-associated protein which comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 27; SEQ ID NO.: 28; SEQ ID NO.: 29; SEQ ID NO.: 30; SEQ ID NO.: 31; SEQ ID NO.: 32; and SEQ ID NO.: 33. Alternatively, the method of the invention may comprise the step of detecting a cervical cancer-associated protein having
10 the amino acid sequence set forth in SEQ ID NO.: 34, commonly referred to in the art as Nup358. See, for example, Wu *et al.* (1995) *J. Biol. Chem.* **270**: 14209-14213, the disclosure of which is incorporated herein by reference.

15 In another preferred embodiment, the methods of the invention may comprise the step of detecting a cervical cancer-associated protein which comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 35; SEQ ID NO.: 36; SEQ ID NO.: 37; SEQ ID NO.: 38; SEQ ID NO.: 39; SEQ ID NO.: 40; SEQ ID NO.: 41; SEQ ID NO.: 42; SEQ ID NO.: 43; SEQ ID NO.: 44; and SEQ ID NO.: 45. Alternatively, the method of the invention may comprise the step of detecting a cervical cancer-associated protein having the amino acid
20 sequence set forth in SEQ ID NO.: 46, commonly referred to in the art as lamin A. See, for example, Fisher *et al.* (1986) *Proc. Natl. Acad. Sci. USA.* **83**: 6450-6454, the disclosure of which is incorporated herein by reference.

The methods of the invention may be performed on any relevant tissue or body fluid
25 sample. For example, methods of the invention may be performed on cervical tissue, more preferably cervical biopsy tissue, and most preferably on Pap smears. Alternatively, the methods of the invention may be performed on a human body fluid sample selected from the group consisting of: blood; serum; plasma; fecal matter; urine; vaginal secretion; spinal fluid; saliva; ascitic fluid; peritoneal fluid; sputum; and breast exudate. It is contemplated, however, that the

methods of the invention also may be useful in assays for metastasized cervical cancer cells in other tissue or body fluid samples.

Marker proteins associated with a cervical cancer in a tissue or body fluid sample may be
5 detected using any of a number of assay methods available in the art. In one embodiment, for
example, the marker cervical cancer-associated protein may be reacted with a labeled binding
moiety capable of specifically binding to the marker protein thereby to produce a labeled
complex of the binding moiety and the marker protein. The labeled complex thereafter may be
detected, using conventional methodologies well known in the art. Detection of the presence of
10 the labeled complex may provide an indication of the presence of the cervical cancer cells or pre-
cancerous cells in the individual being tested. As used herein, the term "binding moiety" is
understood to mean any binding partner capable of specifically binding to a cervical cancer-
associated protein with a binding affinity greater than about 10^5 M^{-1} . As used herein the terms
"specifically binding", "specifically bound" and "binds specifically" refer to a binding interaction
15 with a binding affinity of greater than about 10^5 M^{-1} . As used herein, the binding moiety is
labeled with a detectable moiety, for example, a radioactive, fluoroscopic, spectroscopic, or
enzymatic label, using techniques well known in the art.

It is appreciated that, binding moieties which interact and bind specifically with the target
20 protein, may be designed using conventional methods well known in the art. In the invention,
the binding moiety can be an antibody, for example, a monoclonal or a polyclonal antibody.
Monoclonal antibodies are preferred. It is contemplated, however, that other useful binding
moieties useful in the practice of the instant invention may include, for example, biosynthetic
antibody binding sites, also referred to in the art as BABS or sFv's, and antibody fragments, for
25 example, Fv, Fab, Fab' and (Fab')₂ fragments. Procedures for preparing, testing, and labeling
BABS and antibody fragments are well known in the art, and so are not discussed in detail
herein.

In another embodiment, one or more marker proteins in a sample may be detected by first isolating the proteins from the sample, and then separating the proteins by two-dimensional gel electrophoresis to produce a characteristic two-dimensional gel electrophoresis pattern. The gel electrophoresis pattern then may be compared with a standard, for example, a standard gel pattern obtained from a data base of gel electrophoresis patterns. Thus, in another embodiment, the invention provides electrophoresis gel patterns or electropherograms of cervical cancer-associated proteins which are useful in detecting a cervical cancer in an individual.

The cervical cancer-associated proteins of the invention can be purified or co-purified from cervical cancer cells using nuclear matrix protein isolation procedures, such as those disclosed in U.S. Patent No. 4,885,236 and U.S. Patent No. 4,882,268, the disclosures of which are incorporated herein. Alternatively, the marker proteins, once identified and characterized may be isolated from the sample by any of a range of protein purification protocols well known to those skilled in the art, such as affinity chromatography, to yield isolated proteins. As used herein, the term "isolated" is understood to mean substantially free of undesired, contaminating proteinaceous material.

Furthermore, the skilled artisan may produce nucleic acid sequences encoding the entire isolated marker protein, or fragments thereof, using methods currently available in the art (see, for example, Maniatis *et al.*, eds. (1989) "*Molecular Cloning: A Laboratory Manual*," Cold Spring Harbor Press). For example, an isolated cervical cancer-associated protein may be sequenced using conventional peptide sequencing protocols, and then oligonucleotide hybridization probes designed for screening a cDNA library. The cDNA library then may be screened with the resultant oligonucleotide to isolate full or partial length cDNA sequences which encode the isolated protein.

Furthermore, the skilled artisan, using the methodologies described in U.S. Patent Nos. 4,885,236 and 4,882,268 may isolate from a cell sample a nucleic acid molecule having a sequence capable of recognizing and being specifically bound by a cervical cancer-associated protein. In such a procedure, the soluble proteins are separated from the nucleus and

cytoskeleton by extracting mammalian cells with a non-ionic detergent solution at physiological pH and ionic strength. The insoluble protein and nucleic acids then are digested with DNAase and then eluted with a buffered ammonium sulfate solution to yield a nucleic acid molecule capable of recognizing and being specifically bound by a cervical cancer-associated protein. Any remaining proteins then are separated from the target nucleic acid molecule.

Detection of the aforementioned nucleic acid molecules thus can serve as an indicator of the presence of cervical cancer and/or metastasized cervical cancer in an individual. Accordingly, in another aspect, the invention provides another method for detecting cervical cancer in a human. The method comprises the step of detecting the presence of a nucleic acid molecule in a tissue or body fluid sample thereby to indicate the presence of a cervical carcinoma in the individual. The nucleic acid molecule is selected from the group consisting of (i) a nucleic acid molecule comprising a sequence capable of recognizing and being specifically bound by a cervical cancer-associated protein, and (ii) a nucleic acid molecule comprising a sequence encoding a cervical cancer-associated protein. As defined herein, the cervical cancer-associated protein is characterized as being selected from the group consisting of (i) a protein having a molecular weight of about 69,400 Daltons and an isoelectric point of about 5.8; (ii) a protein having a molecular weight of about 53,800 Daltons and an isoelectric point of about 5.5; (iii) a protein having a molecular weight of about 47,900 Daltons and an isoelectric point of about 5.6; (iv) a protein having a molecular weight of about 46,000 Daltons, and an isoelectric point of about 5.1; and (v) a protein having a molecular weight of about 44,900 Daltons and an isoelectric point of about 6.6, wherein in each example, the molecular weight is determined by standard polyacrylamide gel electrophoresis techniques and the isoelectric point is determined by standard isoelectric focusing techniques, and wherein the cervical cancer-associated protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis.

A target nucleic acid molecule in a sample may be detected, for example, by Northern blot analysis by reacting the sample with a labeled hybridization probe, for example, a ^{32}P labeled oligonucleotide probe, capable of hybridizing specifically with at least a portion of the nucleic acid molecule encoding the marker protein. Detection of a nucleic acid molecule either encoding
5 a cervical cancer-associated protein or capable of being specifically bound by a cervical cancer-associated protein, thus can serve as an indicator of the presence of a cervical cancer in the individual being tested.

In another aspect, the invention provides a kit for detecting the presence of cervical cancer
10 or for evaluating the efficacy of a therapeutic treatment of a cervical cancer. Such kits may comprise, in combination, (i) a receptacle for receiving a human tissue or body fluid sample from the individual, (ii) a binding partner which binds specifically either to an epitope on a marker cervical cancer-associated protein or a nucleic acid sequence encoding at least a portion of the marker cervical cancer-associated protein, (iii) means for detecting the binding of the binding
15 partner with either the cervical cancer-associated protein or the nucleic acid sequence encoding at least a portion of the cervical cancer-associated protein, and (iv) a reference sample.

In one embodiment of the kit, the binding moiety binds specifically to a cervical cancer-associated protein selected from the group of proteins further defined as having: a molecular
20 weight of about 69,400 Daltons and an isoelectric point of about 5.8; a molecular weight of about 53,800 Daltons and an isoelectric point of about 5.5; a molecular weight of about 47,900 Daltons and an isoelectric point of about 5.6; a molecular weight of about 46,000 Daltons and an isoelectric point of about 5.1, or a molecular weight of about 44,900 Daltons and an isoelectric point of about 6.6, wherein the molecular weight is determined by conventional polyacrylamide
25 gel electrophoresis methodologies, and the isoelectric point is determined by conventional isoelectric focusing methodologies.

In another embodiment of the kit, the reference sample may comprise a negative and/or positive control. The negative control being indicative of a normal cervical cell type and the
30 positive control being indicative of cervical cancer.

In another aspect, the invention provides a method for treating cervical cancer. The method comprises administering to a patient with cervical cancer, a therapeutically-effective amount of a compound, preferably an antibody, and most preferably a monoclonal antibody, which binds specifically to a target cervical cancer-associated protein thereby to inactivate the protein. The target protein being characterized as having a molecular weight of from about 44,900 Daltons to about 69,400 Daltons, as determined by standard polyacrylamide gel electrophoresis techniques and an isoelectric point of from about 5.1 to about 6.6, as determined by standard isoelectric focusing techniques, and wherein the target protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis. Similarly, it is contemplated that the compound may comprise a small molecule, for example, as small organic molecule, which inhibits or reduces the biological activity of the target cervical cancer-associated protein.

In another aspect, the invention provides another method for treating cervical cancer. The method comprises the step of administering to a patient diagnosed as having cervical cancer, a therapeutically-effective amount of a compound which reduces *in vivo* the expression of a target cervical cancer-associated protein thereby to reduce *in vivo* the expression of the target protein. In a preferred embodiment, the compound is a nucleobase containing sequence, such as, an anti-sense nucleic acid sequence or anti-sense peptide nucleic acid (PNA) molecule, complementary to a nucleic acid sequence encoding at least a portion of the target protein. After administration, the anti-sense nucleic acid sequence or anti-sense PNA molecule binds to the nucleic acid sequences encoding, at least in part, the target protein thereby to reduce *in vivo* expression of the target cervical cancer-associated protein.

Thus, the invention provides a wide range of methods and compositions for detecting and treating cervical cancer in an individual. Specifically, the invention provides cervical cancer-associated proteins, which permit specific and early, preferably before metastases occur, detection of cervical cancer in an individual. In addition, the invention provides kits useful in the

detection of cervical cancer in an individual. In addition, the invention provides methods utilizing the cervical cancer-associated proteins as targets and indicators, for treating cervical cancers and for monitoring of the efficacy of such a treatment. These and other numerous additional aspects and advantages of the invention will become apparent upon consideration of
5 the following figures, detailed description, and claims which follow.

Brief Description of the Drawings.

Figure 1a is a high resolution two-dimensional gel electrophoresis pattern of nuclear matrix proteins isolated from a cervical cancer tissue sample. Tumor-associated proteins
5 encircled and marked with reference numbers 1-5 correspond to proteins CvC-1 to CvC-5, listed in Table 2.

Figure 1b is a high resolution two-dimensional gel electrophoresis pattern of nuclear matrix proteins isolated from a normal cervical tissue sample. As a reference, the relative
10 positions corresponding to the CvC-1 to CvC-5 proteins of Figure 1a are encircled and marked with reference numbers 1-5.

Figure 2a is a high resolution two-dimensional gel electrophoresis pattern of nuclear matrix proteins isolated from the cervical carcinoma-derived cell line C33A. Tumor-associated
15 proteins CvC-2 and CvC-5 are encircled and marked with reference numbers 2 and 5.

Figure 2b is a high resolution two-dimensional gel electrophoresis pattern of nuclear matrix proteins isolated from CaSki cells. Tumor-associated proteins CvC-1 and CvC-3 are
20 encircled and marked with reference numbers 1 and 3.

For each of the above figures, molecular weight standards are indicated on the ordinate axes ($M_r \times 10^3$) and isoelectric points are shown on the abscissae.

Detailed Description of the Invention.

The present invention provides methods and compositions for the detection and treatment of cervical cancer. The invention is based, in part, upon the discovery of cervical cancer-associated proteins which generally are present at detectably higher levels in cancerous cervical cells than in normal cervical cells, as determined by two-dimensional gel electrophoresis.

The cervical cancer-associated proteins may act as marker proteins useful in the detection of cervical cancer or as target proteins for therapy of cervical cancer. For example, it is contemplated that, the marker proteins and binding moieties, for example, antibodies that bind to the marker proteins or nucleic acid probes which hybridize to nucleic acid sequences encoding the marker proteins, may be used to detect the presence of cervical cancer in an individual.

Furthermore, it is contemplated that, the skilled artisan may produce novel therapeutics for treating cervical cancer which include, for example: antibodies which can be administered to an individual that bind to and reduce or eliminate the biological activity of the target protein *in vivo*; nucleic acid or peptide nucleic acid sequences which hybridize with genes or gene transcripts encoding the target proteins thereby to reduce expression of the target proteins *in vivo*; or small molecules, for example, organic molecules which interact with the target proteins or other cellular moieties, for example, receptors for the target proteins, thereby to reduce or eliminate biological activity of the target proteins.

Set forth below are methods for isolating cervical cancer-associated proteins, methods for detecting cervical cancer using cervical cancer-associated proteins as markers, and methods for treating individuals afflicted with cervical cancer using cervical cancer-associated proteins as targets for cancer therapy.

1. Identification and Purification of Cervical Cancer-associated Proteins.

Marker proteins of the invention, as disclosed herein are identified by (i) isolating proteins from normal cervical tissue and from cervical cancer tissue using a nuclear matrix purification

protocol, such as those described generally in U.S. Pat. Nos. 4,882,268 and 4,885,236, or Fey et al. (1986) *supra* (ii) fractionating the resulting nuclear matrix protein preparations by 2-D gel electrophoresis, (iii) visualizing the resulting protein patterns, for example, by silver staining, and (iv) identifying polypeptide spots on the resulting 2-D gel electropherograms which
5 generally are detectable in samples isolated from cervical cancer cells but not detectable in samples isolated from normal cervical cells.

Marker proteins associated with cervical cancer tissue were isolated as described herein using a modification of the method of Fey et al. (Fey et al. (1986) *supra*). Briefly, cervical
10 cancer tissue is minced into small (1 mm³) pieces and homogenized with a Teflon pestle on ice and treated with a buffered solution containing 0.5% Triton-X-100, vanadyl riboside complex plus a protease inhibitor cocktail (phenylmethyl sulfonyl fluoride, aprotinin, and leupeptin) to remove lipids and soluble proteins. Tumor cells from cell lines can be harvested by trypsinization and treated in the same way as for homogenized tumor tissue. Stromal aggregates
15 are removed by filtering the homogenate through a 250 micron nylon screen followed by a centrifugation step.

Soluble cytoskeletal proteins are removed by incubating the pellet in an extraction buffer containing 250 mM (NH₄)₂SO₄, 0.5% Triton-X-100, vanadyl riboside complex plus a protease
20 inhibitor cocktail for 10 minutes on ice followed by centrifugation. Chromatin is removed by incubating the pellet in DNAase I in a buffered solution containing a protease inhibitor cocktail for 45 minutes at 25°C.

The remaining pellet fraction, containing the target proteins and intermediate filaments, is
25 solubilized in a disassembly buffer containing 8 M urea, protease inhibitor cocktail plus 1% 2-mercaptoethanol. Insoluble contaminants, primarily carbohydrates and extracellular matrix, are removed by ultracentrifugation. Intermediate filaments are allowed to reassemble upon removal of urea by dialysis in assembly buffer containing protease inhibitor cocktail and removed by ultracentrifugation, leaving the target proteins in the supernatant fraction. Protein concentration

can be determined by the Coomassie Plus Protein Assay Kit (Pierce Chemicals, Rockford, IL) using a bovine gamma globulin standard. Proteins are immediately precipitated in 80% ethanol and stored at -80°C until use.

5 It is contemplated that, after identification, the resulting cervical cancer-associated proteins may be isolated by preparing a nuclear matrix protein preparation, such as the one described above, electrophoresing the resulting proteins on a 2-D gel, and after some means of visualization, isolating the protein of interest from the resulting 2-D gel. Alternatively, it is contemplated that the marker protein, once identified, can be isolated, using standard protein
10 purification methodologies well known to those of ordinary skill in the art, such as affinity chromatography, to yield substantially pure marker proteins. As used herein, the term "substantially pure" is understood to mean at least 80% pure as determined by sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE).

15 2. Detection of Cervical Cancer.

Once cervical cancer-associated proteins have been identified, they may be used as
20 markers to determine whether an individual has cervical cancer and/or cervical dysplasia, and if so, suitable detection methods can be used to monitor the status of the disease.

Using the marker proteins, the skilled artisan can produce a variety of detection methods for
detecting cervical cancer in a human. The methods, typically comprise the steps of detecting, by
some means, the presence of one or more cervical cancer-associated proteins in a tissue or body
fluid sample of the human. The accuracy and/or reliability of the method for detecting cervical
25 cancer in a human may be further enhanced by detecting the presence of a plurality of cervical cancer-associated proteins in a preselected tissue or body fluid sample. The detection step may
comprise one or more of the protocols described hereinbelow.

2.A. Protein Detection Methods.

The marker protein in a sample may be reacted with a binding moiety capable of specifically binding the marker protein. The binding moiety may comprise, for example, a member of a ligand-receptor pair, i.e., a pair of molecules capable of having a specific binding interaction. The binding moiety may comprise, for example, a member of a specific binding pair, such as antibody-antigen, enzyme-substrate, nucleic acid-nucleic acid, protein-nucleic acid, protein-protein, or other specific binding pair known in the art. Binding proteins may be designed which have enhanced affinity for a target protein. Optionally, the binding moiety may be linked with a detectable label, such as an enzymatic, fluorescent, radioactive, phosphorescent or colored particle label. The labeled complex may be detected, e.g., visually or with the aid of a spectrophotometer or other detector.

The marker proteins also may be detected using gel electrophoresis techniques available in the art. In two-dimensional gel electrophoresis, the proteins are separated first in a pH gradient gel according to their isoelectric point. The resulting gel then is placed on a second polyacrylamide gel, and the proteins separated according to molecular weight (see, for example, O'Farrell (1975) *J. Biol. Chem.* **250**: 4007-4021).

One or more marker proteins may be detected by first isolating proteins from a sample obtained from an individual suspected of having cervical cancer, and then separating the proteins by two-dimensional gel electrophoresis to produce a characteristic two-dimensional gel electrophoresis pattern. The pattern then may be compared with a standard gel pattern produced by separating, under the same or similar conditions, proteins isolated from normal or cancer cells. The standard may be stored or obtained in an electronic database of electrophoresis patterns. The presence of a cervical cancer-associated protein in the two-dimensional gel provides an indication of the presence of a cervical cancer in the sample being tested. The detection of two or more proteins in the two-dimensional gel electrophoresis pattern further enhances the accuracy of the assay. The presence of a plurality, e.g., two to five, cervical cancer-associated proteins on the two-dimensional gel provides a strong indication of the presence of a

cervical cancer in the sample. The assay thus permits the early detection and treatment of cervical cancer.

2B. Immunoassay.

A marker cervical cancer-associated protein may also be detected using any of a wide range of immunoassay techniques available in the art. For example, the skilled artisan may employ the sandwich immunoassay format to detect cervical cancer in a body fluid sample. Alternatively, the skilled artisan may use conventional immuno-histochemical procedures for detecting the presence of the cervical cancer-associated protein in a tissue sample, for example, in a Pap smear, using one or more labeled binding proteins (See Example 5, hereinbelow).

In a sandwich immunoassay, two antibodies capable of binding the marker protein generally are used, e.g., one immobilized onto a solid support, and one free in solution and labeled with detectable chemical compound. Examples of chemical labels that may be used for the second antibody include radioisotopes, fluorescent compounds, and enzymes or other molecules which generate colored or electrochemically active products when exposed to a reactant or enzyme substrate. When a sample containing the marker protein is placed in this system, the marker protein binds to both the immobilized antibody and the labeled antibody, to form a "sandwich" immune complex on the support's surface. The complexed protein is detected by washing away non-bound sample components and excess labeled antibody, and measuring the amount of labeled antibody complexed to protein on the support's surface.

Both the sandwich immunoassay and the tissue immunohistochemical procedure are highly specific and very sensitive, provided that labels with good limits of detection are used. A detailed review of immunological assay design, theory and protocols can be found in numerous texts in the art, including "*Practical Immunology*", Butt, W.R., ed., (1984) Marcel Dekker, New York and "*Antibodies, A Laboratory Approach*" Harlow *et al.* eds.(1988) Cold Spring Harbor Laboratory.

In general, immunoassay design considerations include preparation of antibodies (e.g., monoclonal or polyclonal antibodies) having sufficiently high binding specificity for the target protein to form a complex that can be distinguished reliably from products of nonspecific interactions. As used herein, the term "antibody" is understood to mean binding proteins, for example, antibodies or other proteins comprising an immunoglobulin variable region-like binding domain, having the appropriate binding affinities and specificities for the target protein. The higher the antibody binding specificity, the lower the target protein concentration that can be detected. A preferred binding specificity is such that the binding protein has a binding affinity for the target protein of greater than about 10^5 M^{-1} , preferably greater than about 10^7 M^{-1} .

Antibodies to an isolated target cervical cancer-associated protein which are useful in assays for detecting a cervical cancer in an individual may be generated using standard immunological procedures well known and described in the art. See, for example, *Practical Immunology*, Butt, N.R., ed., Marcel Dekker, NY, 1984. Briefly, an isolated target protein is used to raise antibodies in a xenogeneic host, such as a mouse, goat or other suitable mammal.

The marker protein is combined with a suitable adjuvant capable of enhancing antibody production in the host, and injected into the host, for example, by intraperitoneal administration. Any adjuvant suitable for stimulating the host's immune response may be used. A commonly used adjuvant is Freund's complete adjuvant (an emulsion comprising killed and dried microbial cells and available from, for example, Calbiochem Corp., San Diego, or Gibco, Grand Island, NY). Where multiple antigen injections are desired, the subsequent injections comprise the antigen in combination with an incomplete adjuvant (e.g., cell-free emulsion).

Polyclonal antibodies may be isolated from the antibody-producing host by extracting serum containing antibodies to the protein of interest. Monoclonal antibodies may be produced by isolating host cells that produce the desired antibody, fusing these cells with myeloma cells using standard procedures known in the immunology art, and screening for hybrid cells (hybridomas) that react specifically with the target protein and have the desired binding affinity.

Antibody binding domains also may be produced biosynthetically and the amino acid sequence of the binding domain manipulated to enhance binding affinity with a preferred epitope on the target protein. Specific antibody methodologies are well understood and described in the literature. A more detailed description of their preparation can be found, for example, in "Practical Immunology" (1984) *supra*

In addition, genetically engineered biosynthetic antibody binding sites, also known in the art as BABS or sFv's, may be used in the practice of the instant invention. Methods for making and using BABS comprising (i) non-covalently associated or disulfide bonded synthetic V_H and V_L dimers, (ii) covalently linked V_H-V_L single chain binding sites, (iii) individual V_H or V_L domains, or (iv) single chain antibody binding sites are disclosed, for example, in U.S. Patent Nos.: 5,091,513; 5,132,405; 4,704,692; and 4,946,778, the disclosures of which are incorporated herein by reference. Furthermore, BABS having requisite specificity for the cervical cancer-associated proteins can be derived by phage antibody cloning from combinatorial gene libraries (see, for example, Clackson *et al.* (1991) *Nature* 352: 624-628). Briefly, a library of phage each of which express on their coat surface, BABS having immunoglobulin variable regions encoded by variable region gene sequences derived from mice pre-immunized with isolated cervical cancer-associated proteins, or fragments thereof, are screened for binding activity against immobilized cervical cancer-associated protein. Phage which bind to the immobilized cervical cancer-associated proteins are harvested and the gene encoding the BABS sequenced. The resulting nucleic acid sequences encoding the BABS of interest then may be expressed in conventional expression systems to produce the BABS protein.

The isolated cervical cancer-associated protein also may be used for the development of diagnostic and other tissue evaluating kits and assays to monitor the level of the proteins in a tissue or fluid sample. For example, the kit may include antibodies or other specific binding proteins which bind specifically with the cervical cancer-associated proteins and which permit

the presence and/or concentration of the cervical cancer-associated proteins to be detected and/or quantitated in a tissue or fluid sample.

Suitable kits for detecting cervical cancer-associated proteins are contemplated to include, e.g., a receptacle or other means for capturing a sample to be evaluated, and means for detecting the presence and/or quantity in the sample of one or more of the cervical cancer-associated proteins described herein. As used herein, "means for detecting" in one embodiment includes one or more antibodies specific for these proteins and means for detecting the binding of the antibodies to these proteins by, e.g., a standard sandwich immunoassay as described herein.

Where the presence of a protein within a cell is to be detected, e.g., as from a tissue sample, the kit also may comprise means for disrupting the cell structure so as to expose intracellular proteins.

2.C. Nucleic Acid-based Assays.

The presence of a cervical cancer in an individual also may be determined by detecting, in a tissue or body fluid sample, a nucleic acid molecule encoding a cervical cancer-associated protein. Using methods well known to those of ordinary skill in the art, the cervical cancer-associated proteins of the invention may be sequenced, and then, based on the determined sequence, oligonucleotide probes designed for screening a cDNA library (see, for example, Maniatis *et al.* (1989) *supra*).

A target nucleic acid molecule encoding a marker cervical cancer-associated protein may be detected using a labeled binding moiety, capable of specifically binding the target nucleic acid.

The binding moiety may comprise, for example, a protein, a nucleic acid or a peptide nucleic acid. Additionally, a target nucleic acid, such as an mRNA encoding a cervical cancer-associated protein, may be detected by conducting, for example, a Northern blot analysis using labeled oligonucleotides, e.g., nucleic acid fragments complementary to and capable of hybridizing specifically with at least a portion of a target nucleic acid. While any length oligonucleotide may be utilized to hybridize an mRNA transcript, oligonucleotides typically within the range of 8-100

nucleotides, preferably within the range of 15-50 nucleotides, are envisioned to be most useful in standard hybridization assays.

The oligonucleotide selected for hybridizing to the target nucleic acid, whether synthesized
5 chemically or by recombinant DNA methodologies, is isolated and purified using standard
techniques and then preferably labeled (e.g., with ^{35}S or ^{32}P) using standard labeling protocols.
A sample containing the target nucleic acid then is run on an electrophoresis gel, the dispersed
nucleic acids transferred to a nitrocellulose filter and the labeled oligonucleotide exposed to the
filter under suitable hybridizing conditions, e.g. 50% formamide, 5 X SSPE, 2 X Denhardt's
10 solution, 0.1% SDS at 42°C, as described in Maniatis *et al.* (1989) *supra*. Other useful
procedures known in the art include solution hybridization, and dot and slot RNA hybridization.
The amount of the target nucleic acid present in a sample optionally then is quantitated by
measuring the radioactivity of hybridized fragments, using standard procedures known in the art.

15 In addition, oligonucleotides also may be used to identify other sequences encoding
members of the target protein families. The methodology also may be used to identify genetic
sequences associated with the nucleic acid sequences encoding the proteins described herein,
e.g., to identify non-coding sequences lying upstream or downstream of the protein coding
sequence, and which may play a functional role in expression of these genes. Additionally,
20 binding assays may be conducted to identify and detect proteins capable of a specific binding
interaction with a nucleic acid encoding a cervical cancer-associated protein, which may be
involved e.g., in gene regulation or gene expression of the protein. In a further embodiment, the
assays described herein may be used to identify and detect nucleic acid molecules comprising a
sequence capable of recognizing and being specifically bound by a cervical cancer-associated
25 protein.

In addition, it is anticipated that using a combination of appropriate oligonucleotide primers,
i.e., more than one primer, the skilled artisan may determine the level of expression of a target
gene *in vivo* by standard polymerase chain reaction (PCR) procedures, for example, by

quantitative PCR. Conventional PCR based assays are discussed, for example, in Innes *et al* (1990) "*PCR Protocols; A guide to methods and Applications*", Academic Press and Innes *et al*. (1995) "*PCR Strategies*" Academic Press, San Diego, CA.

5 **3. Identification of Proteins Which Interact In Vivo With Cervical Cancer-associated Proteins.**

10 In addition, it is contemplated that the skilled artisan, using procedures like those described hereinbelow, may identify other molecules which interact *in vivo* with the cervical cancer-associated proteins described herein. Such molecules also may provide possible targets for chemotherapy.

15 By way of example, cDNA encoding proteins or peptides capable of interacting with cervical cancer-associated proteins can be determined using a two-hybrid assay, as reported in Durfee *et al.* (1993) *Genes & Develop.* 7: 555-559, the disclosure of which is incorporated herein by reference. The principle of the two hybrid system is that noncovalent interaction of two proteins triggers a process (transcription) in which these proteins normally play no direct role, because of their covalent linkage to domains that function in this process. For example, in the two-hybrid assay, detectable expression of a reporter gene occurs when two fusion proteins, one comprising a DNA-binding domain and one comprising a transcription initiation domain,
20 interact.

25 The skilled artisan can use a host cell that contains one or more reporter genes, such as yeast strain Y153, reported in Durfee *et al.* (1993) *supra*. This strain carries two chromosomally located reporter genes whose expression is regulated by Gal4. A first reporter gene, is the *E. coli lacZ* gene under the control of the *Gal4* promoter. A second reporter gene is the selectable *HIS3* gene. Other useful reporter genes may include, for example, the luciferase gene, the *LEU2* gene, and the *GFP* (Green Fluorescent Protein) gene.

30 Two sets of plasmids are used in the two hybrid system. One set of plasmids contain DNA encoding a *Gal4* DNA-binding domain fused in frame to DNA encoding a cervical cancer-

associated protein. The other set of plasmids contain DNA encoding a *Gal4* activation domain fused to portions of a human cDNA library constructed from human lymphocytes. Expression from the first set of plasmids result in a fusion protein comprising a Gal4 DNA-binding domain and a cervical cancer-associated protein. Expression from the second set of plasmids produce a transcription activation protein fused to an expression product from the lymphocyte cDNA library. When the two plasmids are transformed into a gal-deficient host cell, such as the yeast Y153 cells described above, interaction of the *Gal* DNA binding domain and transcription activation domain occurs only if the cervical cancer-associated protein fused to the DNA binding domain binds to a protein expressed from the lymphocyte cDNA library fused to the transcription activating domain. As a result of the protein-protein interaction between the cervical cancer-associated protein and its *in vivo* binding partner detectable levels of reporter gene expression occur.

In addition to identifying molecules which interact *in vivo* with the cervical cancer-associated proteins, the skilled artisan may also screen for molecules, for example, small molecules which alter or inhibit specific interaction between a cervical cancer-associated protein and its *in vivo* binding partner.

For example, host cell can be transfected with DNA encoding a suitable DNA binding domain/cervical cancer-associated protein hybrid and a translation activation domain/putative cervical cancer-associated protein binding partner, as disclosed above. The host cell also contains a suitable reporter gene in operative association with a *cis*-acting transcription activation element that is recognized by the transcription factor DNA binding domain. The level of reporter gene expressed in the system is assayed. Then, the host cell is exposed to a candidate molecule and the level of reporter gene expression is detected. A reduction in reporter gene expression is indicative of the candidate's ability to interfere with complex formation or stability with respect to the cervical cancer-associated protein and its *in vivo* binding partner. As a control, the candidate molecule's ability to interfere with other, unrelated protein-protein complexes is also tested. Molecules capable of specifically interfering with a cervical cancer-associated protein/binding partner interaction, but not other protein-protein interactions, are identified as

candidates for production and further analysis. Once a potential candidate has been identified, its efficacy in modulating cell cycling and cell replication can be assayed in a standard cell cycle model system.

5 Candidate molecules can be produced as described hereinbelow. For example, DNA encoding the candidate molecules can be inserted, using conventional techniques well described in the art (see, for example, Maniatis (1989) *supra*) into any of a variety of expression vectors and transfected into an appropriate host cell to produce recombinant proteins, including both full length and truncated forms. Useful host cells include *E. coli*, *Saccharomyces cerevisiae*, *Pichia*
10 *pastoris*, the insect/baculovirus cell system, myeloma cells, and various other mammalian cells. The full length forms of such proteins are preferably expressed in mammalian cells, as disclosed herein. The nucleotide sequences also preferably include a sequence for targeting the translated sequence to the nucleus, using, for example, a sequence encoding the eight amino acid nucleus targeting sequence of the large T antigen, which is well characterized in the art. The vector can
15 additionally include various sequences to promote correct expression of the recombinant protein, including transcription promoter and termination sequences, enhancer sequences, preferred ribosome binding site sequences, preferred mRNA leader sequences, preferred protein processing sequences, preferred signal sequences for protein secretion, and the like. The DNA sequence encoding the gene of interest can also be manipulated to remove potentially inhibiting sequences
20 or to minimize unwanted secondary structure formation. As will be appreciated by the practitioner in the art, the recombinant protein can also be expressed as a fusion protein.

After translation, the protein can be purified from the cells themselves or recovered from the culture medium. The DNA can also include sequences which aid in expression and/or
25 purification of the recombinant protein. The DNA can be expressed directly or can be expressed as part of a fusion protein having a readily cleavable fusion junction.

The DNA may also be expressed in a suitable mammalian host. Useful hosts include fibroblast 3T3 cells, (e.g., NIH 3T3, from CRL 1658) COS (simian kidney ATCC, CRL-1650) or
30 CHO (Chinese hamster ovary) cells (e.g., CHO-DXB11, from Chasin (1980) *Proc. Nat'l. Acad.*

Sci. USA 77 :4216-4222), mink-lung epithelial cells (MV1Lu), human foreskin fibroblast cells, human glioblastoma cells, and teratocarcinoma cells. Other useful eukaryotic cell systems include yeast cells, the insect/baculovirus system or myeloma cells.

5 In order to express a candidate molecule, the DNA is subcloned into an insertion site of a suitable, commercially available vector along with suitable promoter/enhancer sequences and 3' termination sequences. Useful promoter/enhancer sequence combinations include the CMV promoter (human cytomegalovirus (MIE) promoter) present, for example, on pCDM8, as well as the mammary tumor virus promoter (MMTV) boosted by the Rous sarcoma virus LTR enhancer
10 sequence (e.g., from Clontech, Inc., Palo Alto). A useful inducible promoter includes, for example, A Zn^{2+} inducible promoter, such as the Zn^{2+} metallothionein promoter (Wrana et al. (1992) Cell 71: 1003-1014) Other inducible promoters are well known in the art and can be used with similar success. Expression also can be further enhanced using *trans*-activating enhancer sequences. The plasmid also preferably contains an amplifiable marker, such as DHFR
15 under suitable promoter control, e.g., SV40 early promoter (ATCC #37148). Transfection, cell culturing, gene amplification and protein expression conditions are standard conditions, well known in the art, such as are described, for example in Ausubel *et al.*, ed.,(1989) "*Current Protocols in Molecular Biology*", John Wiley & Sons, NY. Briefly, transfected cells are cultured in medium containing 5-10% dialyzed fetal calf serum (dFCS), and stably transfected high
20 expression cell lines obtained by amplification and subcloning and evaluated by standard Western and Northern blot analysis. Southern blots also can be used to assess the state of integrated sequences and the extent of their copy number amplification.

The expressed candidate protein is then purified using standard procedures. A currently
25 preferred methodology uses an affinity column, such as a ligand affinity column or an antibody affinity column. The column is then washed, and the candidate molecules selectively eluted in a gradient of increasing ionic strength, changes in pH, or addition of mild detergent. It is appreciated that in addition to the candidate molecules which bind to the cervical cancer-associated proteins, the cervical cancer associated proteins themselves may likewise be produced
30 using such recombinant DNA technologies.

4. Cervical Cancer Therapy and Methods for Monitoring Therapy.

The skilled artisan, after identification of cervical cancer-associated proteins and proteins which interact with the cervical cancer-associated proteins, can develop a variety of therapies for treating cervical cancer. Because the marker proteins described herein are present at detectably higher levels in cervical cancer cells relative to normal cervical cells, the skilled artisan may employ, for example, the marker proteins and/or nucleic acids encoding the marker proteins as target molecules for a cancer chemotherapy.

4.A. Anti-sense-based Therapeutics.

A particularly useful cancer therapeutic envisioned is an oligonucleotide or peptide nucleic acid sequence complementary and capable of hybridizing under physiological conditions to part, or all, of the gene encoding the marker protein or to part, or all, of the transcript encoding the marker protein thereby to reduce or inhibit transcription and/or translation of the marker protein gene. Alternatively, the same technologies may be applied to reduce or inhibit transcription and/or translation of the proteins which interact with the cervical cancer-associated proteins.

Anti-sense oligonucleotides have been used extensively to inhibit gene expression in normal and abnormal cells. See, for example, Stein *et al.* (1988) *Cancer Res.* **48**: 2659-2668, for a pertinent review of anti-sense theory and established protocols. In addition, the synthesis and use of peptide nucleic acids as anti-sense-based therapeutics are described in PCT publications PCT/EP92/01219 published November 26, 1992, PCT/US92/10921 published June 24, 1993, and PCT/US94/013523 published June 1, 1995, the disclosures of which are incorporated herein by reference. Accordingly, the anti-sense-based therapeutics may be used as part of chemotherapy, either alone or in combination with other therapies.

Anti-sense oligonucleotide and peptide nucleic acid sequences are capable of hybridizing to a gene and/or mRNA transcript and, therefore, may be used to inhibit transcription and/or translation of the protein described herein. It is appreciated, however, that oligoribonucleotide sequences generally are more susceptible to enzymatic attack by ribonucleases than are deoxyribonucleotide sequences. Hence, oligodeoxyribonucleotides are preferred over oligoribonucleotides for *in vivo* therapeutic use. It is appreciated that the peptide nucleic acid sequences, unlike regular nucleic acid sequences, are not susceptible to nuclease degradation and, therefore, are likely to have greater longevity *in vivo*. Furthermore, it is appreciated that peptide nucleic acid sequences bind complementary single stranded DNA and RNA strands more strongly than corresponding DNA sequences (see, for example, PCT/EP92/20702 published November 26, 1992). Accordingly, peptide nucleic acid sequences are preferred for *in vivo* therapeutic use.

Therapeutically useful anti-sense oligonucleotides or peptide nucleic acid sequences may be synthesized by any of the known chemical oligonucleotide and peptide nucleic acid synthesis methodologies well known and thoroughly described in the art. Alternatively, a complementary sequence to part or all of the natural mRNA sequence may be generated using standard recombinant DNA technologies.

Since the complete nucleotide sequence encoding the entire marker protein as well as additional 5' and 3' untranslated sequences are known for each of the marker proteins and/or can be determined readily using techniques well known in the art, anti-sense oligonucleotides or peptide nucleic acids which hybridize with any portion of the mRNA transcript or non-coding sequences may be prepared using conventional oligonucleotide and peptide nucleic acid synthesis methodologies.

Oligonucleotides complementary to, and which hybridizable with any portion of the mRNA transcripts encoding the marker proteins are, in principle, effective for inhibiting translation of the target proteins as described herein. For example, as described in U.S. Pat. No. 5,098,890, issued March 24, 1992, the disclosure of which is incorporated herein by reference,

oligonucleotides complementary to mRNA at or near the translation initiation codon site may be used to inhibit translation. Moreover, it has been suggested that sequences that are too distant in the 3' direction from the translation initiation site may be less effective in hybridizing the mRNA transcripts because of potential ribosomal "read-through", a phenomenon whereby the ribosome is postulated to unravel the anti-sense/sense duplex to permit translation of the message.

A variety of sequence lengths of oligonucleotide or peptide nucleic acid may be used to hybridize to mRNA transcripts. However, very short sequences (e.g., sequences containing less than 8-15 nucleobases) may bind with less specificity. Moreover, for *in vivo* use, short oligonucleotide sequences may be particularly susceptible to enzymatic degradation. Peptide nucleic acids, as mentioned above, likely are resistant to nuclease degradation. Where oligonucleotide and peptide nucleic acid sequences are to be provided directly to the cells, very long sequences may be less effective at inhibition because of decreased uptake by the target cell. Accordingly, where the oligonucleotide or peptide nucleic acid is to be provided directly to target cells, oligonucleotide and/or peptide nucleic acid sequences containing about 8-50 nucleobases, and more preferably 15-30 nucleobases, are envisioned to be most advantageous.

An alternative means for providing anti-sense oligonucleotide sequences to a target cell is gene therapy where, for example, a DNA sequence, preferably as part of a vector and associated with a promoter, is expressed constitutively inside the target cell. Recently, Oeller *et al.* (Oeller *et al.* (1992) *Science* 254: 437-539, the disclosure of which is incorporated herein by reference) described the *in vivo* inhibition of the ACC synthase enzyme using a constitutively expressible DNA sequence encoding an anti-sense sequence to the full length ACC synthase transcript. Accordingly, where the anti-sense oligonucleotide sequences are provided to a target cell indirectly, for example, as part of an expressible gene sequence to be expressed within the cell, longer oligonucleotide sequences, including sequences complementary to substantially all the protein coding sequence, may be used to advantage.

Finally, therapeutically useful oligonucleotide sequences envisioned also include not only native oligomers composed of naturally occurring nucleotides, but also those comprising

modified nucleotides to, for example, improve stability and lipid solubility and thereby enhance cellular uptake. For example, it is known that enhanced lipid solubility and/or resistance to nuclease digestion results by substituting a methyl group or sulfur atom for a phosphate oxygen in the internucleotide phosphodiester linkage. Phosphorothioates ("S-oligonucleotides" wherein a phosphate oxygen is replaced by a sulfur atom), in particular, are stable to nuclease cleavage, are soluble in lipids, and are preferred, particularly for direct oligonucleotide administration. S-oligonucleotides may be synthesized chemically using conventional synthesis methodologies well known and thoroughly described in the art.

Preferred synthetic internucleoside linkages include phosphorothioates, alkylphosphonates, phosphorodithioates, phosphate esters, alkylphosphonothioates, phosphoramidates, carbamates, carbonates, phosphate triesters, acetamidate, and carboxymethyl esters. Furthermore, one or more of the 5'-3' phosphate group may be covalently joined to a low molecular weight (e.g., 15-500 Da) organic group, including, for example, lower alkyl chains or aliphatic groups (e.g., methyl, ethyl, propyl, butyl), substituted alkyl and aliphatic groups (e.g., aminoethyl, aminopropyl, aminohydroxyethyl, aminohydroxypropyl), small saccharides or glycosyl groups. Other low molecular weight organic modifications include additions to the internucleoside phosphate linkages such as cholesteryl or diamine compounds with varying numbers of carbon residues between the amino groups and terminal ribose. Oligonucleotides with these linkages or with other modifications can be prepared using methods well known in the art (see, for example, U.S. Pat. No. 5,149,798).

Suitable oligonucleotide and or peptide nucleic acid sequences which inhibit transcription and/or translation of the marker proteins can be identified using standard *in vivo* assays well characterized in the art. Preferably, a range of doses is used to determine effective concentrations for inhibition as well as specificity of hybridization. For example, in the cases of an oligonucleotide, a dose range of 0-100µg oligonucleotide/ml may be assayed. Further, the oligonucleotides may be provided to the cells in a single transfection, or as part of a series of transfections. Anti-sense efficacy may be determined by assaying a change in cell proliferation over time following transfection, using standard cell counting methodology and/or by assaying for reduced expression of marker protein, e.g., by immunofluorescence. Alternatively, the ability

of cells to take up and use thymidine is another standard means of assaying for cell division and may be used here, e.g., using ^3H thymidine. Effective anti-sense inhibition should inhibit cell division sufficiently to reduce thymidine uptake, inhibit cell proliferation, and/or reduce detectable levels of marker proteins.

5

It is anticipated that therapeutically effective oligonucleotide or peptide nucleic acid concentrations may vary according to the nature and extent of the neoplasm, the particular nucleobase sequence used, the relative sensitivity of the neoplasm to the oligonucleotide or peptide nucleic acid sequence, and other factors. Useful ranges for a given cell type and oligonucleotide and/or peptide nucleic acid may be determined by performing standard dose range experiments. Dose range experiments also may be performed to assess toxicity levels for normal and malignant cells. It is contemplated that useful concentrations may range from about 1 to 100 $\mu\text{g}/\text{ml}$ per 10^5 cells.

For *in vivo* use, the anti-sense oligonucleotide or peptide nucleic acid sequences may be combined with a pharmaceutical carrier, such as a suitable liquid vehicle or excipient, and optionally an auxiliary additive or additives. Liquid vehicles and excipients are conventional and are available commercially. Illustrative thereof are distilled water, physiological saline, aqueous solutions of dextrose, and the like. For *in vivo* cancer therapies, the anti-sense sequences preferably can be provided directly to malignant cells, for example, by injection directly into the tumor. Alternatively, the oligonucleotide or peptide nucleic acid may be administered systemically, provided that the anti-sense sequence is associated with means for directing the sequences to the target malignant cells.

In addition to administration with conventional carriers, the anti-sense oligonucleotide or peptide nucleic acid sequences may be administered by a variety of specialized oligonucleotide delivery techniques. For example, oligonucleotides may be encapsulated in liposomes, as described in Mannino *et al.* (1988) *BioTechnology* 6: 682, and Felgner *et al.* (1989) *Bethesda Res. Lab. Focus* 11:21. Lipids useful in producing liposomal formulations include, without limitation, monoglycerides, diglycerides, sulfatides, lysolecithin, phospholipids, saponin, bile

acids, and the like. Preparation of such liposomal formulations is within the level of skill in the art (see, for example, in U.S. Pat. No. 4,235,871; U.S. Pat. No. 4,501,728; U.S. Pat. No. 4,837,028; and U.S. Pat. No. 4,737,323). The pharmaceutical composition of the invention may further include compounds such as cyclodextrins and the like which enhance delivery of oligonucleotides into cells. When the composition is not administered systemically but, rather, is injected at the site of the target cells, cationic detergents (e.g. Lipofectin) may be added to enhance uptake. In addition, reconstituted virus envelopes have been successfully used to deliver RNA and DNA to cells (see, for example, Arad *et al.* (1986) *Biochem. Biophys. Acta.* 859: 88-94).

For therapeutic use *in vivo*, the anti-sense oligonucleotide and/or peptide nucleic acid sequences are administered to the individual in a therapeutically effective amount, for example, an amount sufficient to reduce or inhibit target protein expression in malignant cells. The actual dosage administered may take into account whether the nature of the treatment is prophylactic or therapeutic in nature, the age, weight, health of the patient, the route of administration, the size and nature of the malignancy, as well as other factors. The daily dosage may range from about 0.01 to 1,000 mg per day. Greater or lesser amounts of oligonucleotide or peptide nucleic acid sequences may be administered, as required. As will be appreciated by those skilled in the medical art, particularly the chemotherapeutic art, appropriate dose ranges for *in vivo* administration would be routine experimentation for a clinician. As a preliminary guideline, effective concentrations for *in vitro* inhibition of the target molecule may be determined first.

4.B. Binding Protein-based Therapeutics.

As mentioned above, a cancer marker protein or a protein that interacts with the cancer marker protein may be used as a target for chemotherapy. For example, a binding protein designed to bind the marker protein essentially irreversibly can be provided to the malignant cells, for example, by association with a ligand specific for the cell and known to be absorbed by the cell. Means for targeting molecules to particular cells and cell types are well described in the chemotherapeutic art.

Binding proteins may be obtained and tested using technologies well known in the art. For example, the binding portions of antibodies may be used to advantage. It is contemplated, however, that intact antibodies or BABS, which preferably, have been humanized may be used in the practice of the invention. As used herein, the term "humanized" is understood to mean a process whereby the framework region sequences of a non-human immunoglobulin variable region are replaced by human variable region sequences. Accordingly, it is contemplated that such humanized binding proteins will elicit a weaker immune response than their unhumanized counterparts. Particularly useful are binding proteins identified with high affinity for the target protein, e.g., greater than about 10^9 M^{-1} . Alternatively, DNA encoding the binding protein may be provided to the target cell as part of an expressible gene to be expressed within the cell following the procedures used for gene therapy protocols well described in the art. See, for example, U.S. Patent No. 4,497,796, and "*Gene Transfer*", Vijay R. Baichwal, ed., (1986). It is anticipated that, once bound by binding protein, the target protein will be inactivated or its biological activity reduced thereby inhibiting or retarding cell division.

As described above, suitable binding proteins for *in vivo* use, may be combined with a suitable pharmaceutical carrier, such as physiological saline or other useful carriers well characterized in the medical art. The pharmaceutical compositions may be provided directly to malignant cells, for example, by direct injection, or may be provided systemically, provided the binding protein is associated with means for targeting the protein to target cells. Finally, suitable dose ranges and cell toxicity levels may be assessed using standard dose range experiments.

Therapeutically effective concentrations may range from about 0.01 to about 1,000 mg per day. As described above, actual dosages administered may vary depending, for example, on the nature of the malignancy, the age, weight and health of the individual, as well as other factors.

4.C. Small Molecule-based Therapeutics.

After having isolating cervical cancer-associated nuclear matrix proteins, the skilled artisan can, using methodologies well known in the art, can screen small molecule libraries

(either peptide or non-peptide based libraries) to identify candidate molecules that reduce or inhibit the biological function of the cervical cancer-associated proteins. The small molecules preferably accomplish this function by reducing the *in vivo* expression of the target molecule, or by interacting with the target molecule thereby to inhibit either the biological activity of the target molecule or an interaction between the target molecule and its *in vivo* binding partner.

It is contemplated that, once the candidate small molecules have been elucidated, skilled artisan may enhance the efficacy of the small molecule using rational drug design methodologies well known in the art. Alternatively, the skilled artisan may use a variety of computer programs which assist the skilled artisan to develop quantitative structure activity relationships (QSAR) which further to assist the design of additional candidate molecules *de novo*. Once identified, the small molecules may be produced in commercial quantities and subjected to the appropriate safety and efficacy studies.

It is contemplated that the screening assays may be automated thereby facilitating the screening of a large number of small molecules at the same time. Such automation procedures are within the level of skill in the art of drug screening and, therefore, are not discussed herein. Candidate peptide based small molecules may be produced by expression of an appropriate nucleic acid sequence in a host cell or using synthetic organic chemistries. Similarly, non-peptidyl-based small molecules may be produced using conventional synthetic organic chemistries well known in the art.

As described above, for *in vivo* use, the identified small molecules may be combined with a suitable pharmaceutical carrier, such as physiological saline or other useful carriers well characterized in the medical art. The pharmaceutical compositions may be provided directly to malignant cells, for example, by direct injection, or may be provided systemically, provided the binding protein is associated with means for targeting the protein to target cells. Finally, suitable dose ranges and cell toxicity levels may be assessed using standard dose range experiments. As described above, actual dosages administered may vary depending, for example, on the nature of the malignancy, the age, weight and health of the individual, as well as other factors.

4.D. Methods for Monitoring the Status of Cervical Cancer in an Individual

The progression of the cervical cancer or the therapeutic efficacy of chemotherapy may be measured using procedures well known in the art. For example, the efficacy of a particular chemotherapeutic agent can be determined by measuring the amount of a cervical cancer-associated protein released from cervical cancer cells undergoing cell death. As reported in PCT publication PCT/US92/09220, published May 13, 1993, incorporated by reference herein, soluble nuclear matrix proteins and fragments thereof are released by cells upon cell death. Such soluble nuclear matrix proteins can be quantitated in a body fluid and used to monitor the degree or rate of cell death in a tissue.

For example, the concentration of a body fluid-soluble nuclear matrix proteins or a fragment thereof released from cells is compared to standards from healthy, untreated tissue. Fluid samples are collected at discrete intervals during treatment and compared to the standard. It is contemplated that changes in the level of a body fluid soluble cervical cancer-associated protein, will be indicative of the efficacy of treatment (that is, the rate of cancer cell death). It is contemplated that the release of body fluid soluble interior nuclear matrix proteins can be measured in blood, plasma, urine, sputum, vaginal secretion, and breast exudate.

Where the assay is used to monitor tissue viability or progression of cervical cancer, the step of detecting the presence and abundance of the marker protein or its transcript in samples of interest is repeated at intervals and these values then are compared, the changes in the detected concentrations reflecting changes in the status of the tissue. For example, an increase in the level of cervical cancer-associated proteins may correlate with progression of the cervical cancer.

Where the assay is used to evaluate the efficacy of a therapy, the monitoring steps occur following administration of the therapeutic agent or procedure (e.g., following administration of a chemotherapeutic agent or following radiation treatment). Similarly, a decrease in the level of cervical cancer-associated proteins may correlate a regression of the cervical cancer.

Thus, cervical cancer may be identified by the presence of cervical cancer-associated proteins as taught herein. Once identified, the cervical cancer may be treated using compounds which reduce *in vivo* the expression and/or biological activity of the cervical cancer-associated proteins. Furthermore, the methods provided herein can be used to monitor the progression of the disease and/or treatment of the disease. The following non limiting examples provide details of the isolation and characterization of cervical cancer-associated proteins and methods for their use in the detection of cervical cancer.

Example 1

Isolation of Cervical Cancer-Associated Nuclear Matrix Proteins From Cervical Cancer Tissue Samples and Cell Lines.

Cervical cancer-associated proteins were identified by comparing silver stained 2-D gel patterns of proteins isolated from normal and cancerous cervical cells.

Fresh cervical carcinoma tissue was obtained from patients undergoing hysterectomy for clinically localized (stage IB, II or III, International Federation of Gynecology and Obstetrics or FIGO classification) carcinomas of the cervix from the Instituto Nacional de Cancerologia in Mexico City, Mexico, in accordance with Scientific and Ethics Committee Review Board approval. A small number of tumor tissues were obtained under Institutional Review Board approval from the Pittsburgh Cancer Center (Pittsburgh, PA). Normal cervical tissue was obtained under Institutional Review Board approval from patients undergoing hysterectomy for causes unrelated to abnormal cervical histopathology, via the Cooperative Human Tissue Network (Columbus, OH). Clinical staging and tumor histopathology for twenty patients who provided tissue samples for use in these experiments are shown in Table 1. With the exception of one case of adenosquamous carcinoma, all of the tumors were squamous cell carcinomas. A majority of these were of the large cell non-keratinizing type. All the patients had localized disease with clinical stages ranging from IB to IIIB (Table 1).

TABLE 1. Patient Age, Clinical Staging and Histopathology.

Case Number	Patient Age	FIGO Stage	Histopathological Diagnosis
1	37	IB	LCNKS [†]
2	49	IB	LCKS [‡]
3	32	IB	Squamous, mod. well diff.*
4	60	IIA	LCNKS
5	63	III	Adenosquamous
6	35	IB	LCKS
7	44	IIIB	LCNKS
8	31	IB	Squamous, poorly diff. [§]
9	31	IB	LCNKS
10	38	IIB	LCKS
11	65	IIB	LCNKS
12	35	IB	LCNKS
13	43	IB	LCNKS
14	65	III	LCNKS
15	52	IIB	LCKS
16	47	III	LCNKS
17	33	IB	LCNKS
18	51	IIIB	LCNKS
19	45	IIB	LCNKS
20	39	IIB	LCNKS

FIGO Stage	IB	IIA	IIB	III	IIIB
<i>n</i>	9	1	5	3	2

[†], Large cell nonkeratinizing squamous cell carcinoma

[‡], Large cell keratinizing squamous cell carcinoma

^{*}, Squamous cell carcinoma, moderately well differentiated

[§], Squamous cell carcinoma, poorly differentiated

Fresh tissue was obtained during surgery, placed into transport medium (RPMI 1640 supplemented with gentamicin and 10% fetal calf serum (GIBCO)), packed in ice, and shipped to Matritech, Inc. by overnight carrier. In a small number of cases where immediate shipment could not be arranged, tissues specimens were snap-frozen in liquid nitrogen and sent on dry ice

to Matritech, Inc. by overnight carrier. Minimum size of tissue specimens was 0.2 gram. Diagnosis was obtained from pathology reports that accompanied each specimen.

5 Nuclear matrix proteins were isolated from cervical cancer tissue using a modification of the method of Fey *et al.* (1986) *supra*. Fresh cervical cancer tissue specimens, ranging in size from about 0.2 g to about 1.0 g, were obtained from 20 different patients. Tissue specimens were minced into small (1 mm^3) pieces and homogenized with a Teflon pestle on ice and treated with a buffered solution containing 0.5% Triton-X-100, vanadyl riboside complex (RNAase inhibitor, Five Prime-Three Prime, Inc.) plus a protease inhibitor cocktail containing
10 phenylmethyl sulfonyl fluoride (Sigma Chemical Co.), aprotinin and leupeptin (Boehringer Mannheim), to remove lipids and soluble proteins.

15 Stromal aggregates were removed by filtering the homogenate through 250 micron Nitex nylon screen (Tetko, Inc.) followed by a centrifugation step ($600 \times g$, 4°C , 5min). Soluble cytoskeletal proteins were removed by incubating the pellet in an extraction buffer containing 250 mM $(\text{NH}_4)_2\text{SO}_4$, 0.5% Triton X-100, vanadyl riboside complex and protease inhibitor cocktail on ice for 10 minutes followed by centrifugation ($600 \times g$, 4°C , 5min).

20 Chromatin was removed by incubating the pellet in DNAase (100 mg/mL, Boehringer-Mannheim) in a buffered solution containing protease inhibitor cocktail for 45 minutes at 25°C . The remaining pellet fraction, which contained nuclear matrix proteins and intermediate filaments, was solubilized in disassembly buffer containing 8 M urea, protease inhibitor cocktail and 1% (vol/vol) 2-mercaptoethanol. Insoluble contaminants, primarily carbohydrates and extracellular matrix were removed by ultracentrifugation ($163,000 \times g$, 20°C , 1 hr). Intermediate
25 filaments were allowed to reassemble upon removal of urea by dialysis in an assembly buffer containing 150 mM KCl, 24 mM imidazole HCl, 5 mM MgCl_2 , 0.125 mM EGTA and 2 mM dithiothreitol (DTT) with protease inhibitors and were removed by ultracentrifugation ($109,000 \times g$, 15°C , 1.5 hr), leaving the nuclear matrix proteins in the supernatant fraction.

In addition, cervical cancer-associated proteins were isolated from CaSki, ME-180, C33A, HeLa (S3 subline), SiHa, C4-1, C4-11, and HT-3 cervical tumor cell lines. Each cell line was obtained from the American Type Culture Collection (ATCC) and maintained at 37°C in 5% CO₂ in Dulbecco's Modified Eagles Medium supplemented with 10% fetal calf serum, gentamicin, fungizone and 0.12% SeraExtend (Irvine Scientific). For nuclear matrix extraction studies, cells were grown to approximately 80% confluence in 10 stage cell culture factories (Nunc), harvested by trypsinization, counted and extracted in the same manner as homogenized tumor tissue. Protein concentration of nuclear matrix proteins was determined by the Coomassie Plus Protein Assay Kit (Pierce Chemical) using a bovine gamma globulin standard. Proteins were immediately precipitated in 80% ethanol and stored at -80°C until use.

The resulting nuclear matrix proteins were next characterized by high-resolution two-dimensional gel electrophoresis according to the procedure of O'Farrell (1975) *J. Biol. Chem.* **250**: 4007-4021 (1975), on an Investigator 2-D system (Oxford Glycosystems, Bedford, MA). Nuclear matrix proteins were solubilized for isoelectric focusing (IEF) analysis in sample buffer containing 9 M urea, 65 mM 3-[(cholamidopropyl)dimethylamino]-1-propanesulfate (CHAPS), 2.2% ampholytes, and 140 mM dithiothreitol (DTT). Two hundred micrograms of nuclear matrix proteins were loaded per gel.

One-dimensional isoelectric focusing was carried out for 18,000 volt-hours using 1 mm x 18 mm gel tubes. Following first dimension electrophoresis, gels were extruded from gel tubes, equilibrated for 2 minutes in a buffer containing 0.3 M Tris base, 0.075 M Tris-HCl, 3.0% SDS, 50 mM DTT, and 0.01% bromophenol blue and placed on top of 1 mm 10% Tris-glycine-SDS Duracryl (Oxford Glycosystems) high tensile strength polyacrylamide electrophoresis slab gels. Second dimension slab gels were electrophoresed at 16 Watts per gel and 12 °C constant temperature for approximately 5 hours. Molecular weight standards consisted of bovine albumin (M_r 66,000), ovalbumin (M_r 45,000), glyceraldehyde-3-phosphate dehydrogenase (M_r 36,000), carbonic anhydrase (M_r 29,000), bovine pancreatic trypsinogen (M_r 24,000), and soybean trypsin inhibitor (M_r 20,100) (Sigma Chemical Co.). Isoelectric points were determined using internal

control proteins with well-characterized isoelectric points. Following electrophoresis, gels were fixed in a solution containing 40% ethanol/10% acetic acid followed by treatment with a solution containing 0.5% glutaraldehyde. Gels were washed extensively and silver stained according to the method of Rabilloud *et al.* (Rabilloud *et al.* (1992) *Electrophoresis* 13: 429-439) and dried between sheets of cellophane paper.

Silver-stained gels were imaged using a MasterScan Biological Imaging System (CSP, Inc., Billerica, MA) according to the manufacturer's instructions. Digital filtering algorithms were used to remove both uniform and non-uniform background without removing critical image data. Two-D scan (TM) two-dimensional gel analysis and database software (version 3.1) using multiple Gaussian least-squares fitting algorithms were used to compute spot patterns into optimal-fit models of the data as reported by Olson *et al.* (1980) *Anal. Biochem.* 169: 49-70. Triangulation from the internal standards was used to precisely determine the molecular weight and isoelectric point of each target protein of interest. Interpretive densitometry was performed using specific software application modules to integrate the data into numeric and graphical reports for each gel being analyzed.

Example 2

Identification of Cervical Cancer-associated Nuclear Matrix Proteins Having Differential Appearance on 2-D Gels.

As described in the previous Example, 2-D gel electrophoresis patterns were obtained by fractionating proteins isolated from either normal or cancerous cervical cells. Figure 1a shows a typical cervical cancer-associated nuclear matrix protein pattern obtained from cervical cancer tissue. Figure 1b shows a typical gel pattern produced by nuclear matrix proteins obtained from a normal cervical tissue sample. Approximately 600 proteins were resolved per gel. Most of the proteins observed were always present, irrespective of the type of cervical tissue under investigation.

Comparison of Figures 1 and 2 reveals that, while most proteins in the cancer and non-cancer samples are identical, there are five proteins that are unique to the cervical cancer sample (labeled in Figure 1). The proteins, designated CvC-1 through CvC-5, were detected in 20 tissue samples obtained from patients diagnosed with cervical carcinoma but were not detected in cervical tissue isolated from a group of 10 normal individuals. Table 2 identifies proteins, designated CvC-1 through CvC-5, by their approximate molecular weight and isoelectric point. Both the molecular weight and isoelectric point values listed in Table 1 are approximate and accurate to within 2,000 Daltons for molecular weight and to within 0.2 pI units for isoelectric point. A detailed analysis to identify proteins common to normal cervical tissue but absent from cervical cancer tissue did not reveal any proteins that were specifically associated with normal cervical tissue.

Table 2: Cervical Cancer-associated Proteins

Peptide	Molecular Weight	Isoelectric Point	Cervical Cancer	Normal Cervical
CvC-1	69,408	5.78	+	-
CvC-2	53,752	5.54	+	-
CvC-3	47,887	5.60	+	-
CvC-4	46,006	5.07	+	-
CvC-5	44,864	6.61	+	-

In addition, the expression of nuclear matrix proteins isolated from cervical cancer cell lines was investigated, the results of which are summarized in Table 3, below. It is known that tumors of epithelial cell origin are characterized by the presence of stroma and other elements, such as those resulting from infiltrating inflammatory cells. Detection of nuclear matrix or matrix-associated proteins in tumor cell lines derived from cervical epithelial cell tumors reduces the possibility that the proteins are the result of stromal or other types of contamination of the nuclear matrix preparation.

2-D gel electrophoresis patterns were obtained from samples containing cervical cancer cells derived from cervical cancer cell lines. Figure 2a shows a cervical cancer-associated nuclear matrix protein pattern obtained from the cervical cancer cell line C33A. In Figure 2a, tumor-associated proteins CvC-2 and CvC-5 are encircled and identified with numbers 2 and 5. Figure 2b shows a gel pattern produced by nuclear matrix proteins obtained from the cervical cancer cell line CaSki a normal cervical tissue sample. In Figure 2b, tumor associated proteins CvC-1 and CvC-3 are encircled and identified with numbers 1 and 3.

Four of the five tumor-associated proteins (CvC1 to CvC-3 and CvC-5) were reproducibly detected in one or more cervical tumor cell lines (Figure 2, Table 3), confirming the epithelial origin of the proteins. Expression of the fifth protein, CvC-4, was variable but could be detected in the C33A tumor cell line (Table 3).

Table 3. Cervical Carcinoma-associated Protein Expression in Cervical Tumor Cell Lines.

Tumor cell line	Histopathology of tumor or origin	Nuclear matrix proteins expressed*				
		CvC-1	CvC-2	CvC-3	CvC-4	CvC-5
CaSKI [†]	Epidermoid	+	tr [‡]	+	-	+
SiHa	Squamous cell	-	tr	+++	-	+
HeLa	Adenocarcinoma	tr	-	+++	-	+
ME-180 [†]	Epidermoid	-	tr	+	-	+
C33A	Squamous cell	+	++	-	var [§]	+
C4-I	Squamous cell	tr	-	+++	-	+
C4-II	Squamous cell	-	-	-	-	tr
HT-3 [†]	Epidermoid	tr	-	+	-	tr

* Nuclear matrix proteins were extracted from tumor cell lines obtained from the American Type Culture Collection using Fey and Penman extraction methodology.

[†] Tumor cell lines arising from metastatic epidermoid carcinoma originating from cervix.

[‡] Indicates low level expression, detected by silver stain.

[§] Indicates variable expression, detected by silver stain.

Two of the cervical cancer-associated proteins specific to cervical cancer cells were isolated and processed for microsequence analysis.

Example 3

Characterization of Cervical Cancer-Associated Nuclear Matrix Protein Markers.

Two protein staining spots detectable on a 2-D gel corresponding to CvC-3 and CvC-5 were isolated, the protein harvested and subjected to microsequence analysis, as described hereinbelow.

For sequencing of the cervical cancer-associated polypeptides CvC-3 and CvC-5, the nuclear matrix fraction from HeLa cells were electrophoresed on two-dimensional gels as described above. Each gel was loaded with 300 micrograms of protein isolated by the nuclear matrix protein isolation procedure, as described above. Following the second-dimension of electrophoresis, proteins were visualized by reverse staining. Briefly, gels were soaked in 200 mM imidazole for 10 minutes, rinsed for 1 minute in water, followed by 1-2 minutes in 300 mM zinc chloride (Fernandez-Patron *et al.* (1992) *BioTechniques* **12**: 564-573). After the protein-containing spots began to appear, the gels were placed in water, and the relevant gels spots excised. The isolated gel spots representing individual cervical cancer-associated polypeptides were pooled and destained by a 5 minute wash in 2% citric acid, followed by several washes in 100 mM Tris hydrochloride at pH 7.0 to raise the pH within the gel pieces.

Each set of pooled gel fragments was then diluted with an equal volume of 2X sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) sample buffer (250mM Tris-Cl, 2% SDS, 20% glycerol, 0.01% bromophenol blue and 10% β -mercaptoethanol, pH 6.8) and incubated at 75°C for 3 minutes. The gel fragment-containing samples were then cooled on ice and loaded onto a 4% polyacrylamide stacking/11% polyacrylamide separating SDS-PAGE gel, and electrophoresed in 1X Tank Buffer (24mM Tris-HCl, 192 mM glycine, 1% SDS, pH 8.3) to focus the gel spots into bands. Molecular weight markers (BioRad #161-0304) were used on

each gel to relate the observed molecular weights on the one-and two-dimensional gels. Following electrophoresis, these gels were electroblotted onto Immobilon PVDF membranes (Oxford Glycosystems, Inc.) (Towbin *et al.* (1979) *Proc. Nat'l. Acad. Sci. USA* 76: 4350-4354) as modified by Matsudaira (Matsudaira *et al.* (1987) *J. Biol. Chem.* 262: 10035) for the mini-gel format. The membranes were then stained for 1 minute with Buffalo Black (0.1% in 1% acetic acid, 40% methanol) and rinsed with water. Regions of membrane containing polypeptide bands were excised with a clean scalpel.

The PVDF-bound polypeptides were then subjected to tryptic peptide mapping and microsequencing (Fernandez *et al.* (1994) *Analytical Biochem.* 218: 112-117) at the Microchemistry Facility at the Worcester Foundation for Biomedical Research using a Hewlett Packard Model 1090M HPLC. Sequence determinations were made on an Applied Biosystems ProCise Sequenator, and most were confirmed by MALDI-TOF mass spectrometry of individual peptides. Other peptides were identified by mass analysis alone, or mass analysis of carboxypeptidase-digested material.

Microsequence Analysis of CvC-3 Peptides.

Using the methodology described above, CvC-3 was isolated from approximately 120 two-dimensional gels of HeLa nuclear matrix and refocused on Immobilon-PVDF membrane for microsequence analysis. Although only one protein was observed by silver staining the 2-D gel location identified as CvC-3, refocusing of the protein on a one dimensional 11% minigel resulted in the resolution of two clearly separable protein bands. These proteins were labeled as CvC-3H and CvC-3L and submitted separately for microsequence analysis. Analysis of the tryptic maps indicates that two different proteins were contained in the two bands seen on the refocusing minigel, since little overlap was observed in the peak retention times of the two peptides.

Ten masses were detected by mass spectrometry from seven of the CvC-3H peaks. Amino acid sequence was obtained for three peptides, two by Edman degradation and one by

carboxypeptidase-MALDI-TOF analysis. The sequences obtained for these peptides, shown in Table 4 match a protein known as IEF SSP 9502 or “novel human nuclear phosphoprotein”. (Honore *et al.* (1994) *supra*; GenBank Accession #LO7758). The complete amino acid sequence for this protein, as derived from a gene sequence, is shown in SEQ. ID No.: 10. Seven other masses from peak fractions separated on the CvC-3H tryptic map also matched those of predicted tryptic fragments from this protein. Mass correlation data of tryptic peptides from CvC-3H are summarized in Table 4. The predicted molecular weight of the nuclear phosphoprotein, based upon its nucleotide sequence is 55 kDa, whereas its observed molecular weight by 2-D gel analysis is 79 kDa (Honore *et al.* (1994) *supra*).

Table 4. Mass Correlation of CvC-3H-derived Tryptic Peptides

Peak	Observed Mass (Da)	Predicted Mass (Da)	Delta	Sequence	SEQ. ID. No.	Protein
4	1110.64	1109.25	0.13%	PAASLAVHTDK	1	IEF SSP 9502
5	834.62	835.92	0.16%	FSGQIER	2	IEF SSP 9502
7	1056.57	1057.26	0.07%	RLIAEAKEK	3	IEF SSP 9502
8	1187.45	1185.37	0.18%	PSLVHSRDM	4	IEF SSP 9502
10	1774.73	1766.93	0.44%	<u>VWDISTVSSVNEAFGR*</u>	5	IEF SSP 9502
10	1802.22	1805.02	0.16%	LVLGSARNSSISGPFGR	6	IEF SSP 9502
11	2746.27	2743.02	0.12%	SDKPIFTLNAHNDEISGLDLSSQIK**	7	IEF SSP 9502
12	2412.23	2409.68	0.11%	<u>VQTLQFHPFEAQTLISGSYDK*</u>	8	IEF SSP 9502
12	2475.13	2483.98	0.36%	MGVLCSSCCPDLPFIYAFGGQK	9	IEF SSP 9502

* Underlining reflects sequences confirmed by Edman degradation.

** Bolded underlining reflects sequence confirmed by carboxypeptidase digestion.

In addition, seven masses were detected by mass spectrometry from four peaks derived from tryptic digestion of CvC-3L. One of these was directly sequenced and was found to be identical to cytokeratin 17 (Trojanovsky *et al.* (1992), *supra*; GenBank Accession # Q04695). Six other masses from fractions separated on the CvC-3L tryptic map also matched those of predicted tryptic fragments of human cytokeratin 17. The amino acid sequence for this protein,

from Troyanovsky *et al.* (1992), *supra*, is shown in SEQ. ID No.: 18. Mass correlation data of tryptic peptides from CvC-3L are summarized in Table 5. The apparent molecular weight of CvC-3L (47.9 kDa) is consistent with the detection of a full length molecule of cytokeratin 17 (predicted molecular weight, 48 kDa) in cervical tumors.

5

Table 5. Mass Correlation of CvC-3L-derived Tryptic Peptides.

<u>Peak</u>	<u>Observed Mass (Da)</u>	<u>Predicted Mass (Da)</u>	<u>Delta</u>	<u>Sequence</u>	<u>SEQ. ID No.</u>	<u>Protein</u>
4	995.46	994.03	0.14%	DYSQYYR	11	Cytokeratin 17
4	1244.97	1242.34	0.21%	NHEEEMNALR	12	Cytokeratin 17
9	1518.03	1516.67	0.09%	<u>LLEGEDAHLTQYK*</u>	13	Cytokeratin 17
10	791.19	790.94	0.03%	ILNEMR	14	Cytokeratin 17
10	835.16	832.91	0.27%	SEISELR	15	Cytokeratin 17
12	1144.21	1144.21	0.00%	DAEDWFFSK	16	Cytokeratin 17
12	1187.57	1186.33	0.10%	LSVEADINGLR	17	Cytokeratin 17

* Underlining reflects sequences confirmed by Edman degradation.

Microsequence Analysis of CvC-5 Peptides.

The gel spot identified as CvC-5 was collected from HeLa nuclear matrix from the same preparative two-dimensional gels that were used for the collection of CvC-3. Approximately 100 gel spots were collected as described and refocused on Immobilon-PVDF membrane for microsequence analysis. During the initial identification of tumor associated proteins it was noted that in some cervical tumors, two proteins appeared to migrate very closing together in the location identified as CvC-5. Only one protein was clearly apparent. However, when the expression of this protein was examined in cervical tumor cell lines, 3 of 8 cell lines showed the presence of at least two proteins in the area defined by CvC-5 (Table 3). Without wishing to be bound by theory, one explanation for the apparent detection of only one protein in the CvC-5 gel

spot in many tumors is that one of the proteins may be more abundant, thereby masking the presence of other closely migrating proteins. When CvC-5 gel spots were pooled and refocused onto a one dimensional minigel, only one diffusely stained protein band was detected.

5 The tryptic map of the diffuse band containing the polypeptide components of the CvC-5 gel spot contained approximately 30 resolved peaks. Mass analysis was performed on 12 of these peaks and 30 masses were obtained. Six amino acid sequences were obtained by automated Edman degradation, revealing the presence of three distinct polypeptides. The first of these is a protein known as TDP-43 or TAR DNA binding protein (Out *et. al.* (1995) *supra*;
10 GenBank Accession # U23731). The complete amino acid sequence, as derived from the gene sequence for this protein, is shown in SEQ. ID. No. 26. The apparent molecular weight of 43 kDa suggests identification of the intact protein in cervical tumors. Six other masses from fractions separated on the CvC-5 tryptic map also matched those of predicted tryptic fragments from this protein. Mass correlation data and peptide sequence data of tryptic peptides matching
15 TDP-43 are shown in Table 6.

Table 6. Mass Correlation of CvC-5 Derived Tryptic Peptides.

<u>Peak</u>	<u>Observed Mass (Da)</u>	<u>Predicted Mass (Da)</u>	<u>Delta</u>	<u>Sequence</u>	<u>SEQ. ID. No.</u>	<u>Protein</u>
12	1729.01	1726.79	0.13%	FGGNPGGFGNQGGFGNSR	19	TDP43
13	655.72	653.78	0.30%	WCDCK	20	TDP43
13	834.24	833.89	0.04%	TTEQDLK	21	TDP43
14	682.63	681.79	0.12%	GFGFVR	22	TDP43
16	1511.88	1511.66	0.01%	LPNSKQSQDEPLR	23	TDP43
21	1280.01	1281.41	0.11%	KMDETDASSAVK	24	TDP43
25	1342.84	1341.61	0.09%	<u>TSDLIVLGLPWK*</u>	25	TDP43

20 * Underlining reflects sequences confirmed by Edman degradation.

Sequence information obtained for three peptides matched a nuclear pore protein known as nucleoporin or Nup358 (Wu *et al.* (1995) *supra*, Gen Bank Accession # L41840). The complete amino acid sequence, as derived from the gene sequence, is shown in SEQ. ID. No.:34. Mass correlation data for five additional masses identified from the CvC-5 tryptic map which matched predicted tryptic fragments of Nup358 are shown in Table 7. The location of the sequences matching Nup358 suggests our isolation of a C-terminal fragment of the intact protein (M_r 358 kDa) from cervical tumors.

Table 7. Mass Correlation of CvC-5 Derived Tryptic Peptides.

Peak	Observed Mass (Da)	Predicted Mass (Da)	Delta	Sequence	SEQ. ID No.	Protein
9	613.14	614.66	0.25%	NY [*] YR	27	nup358
10	613.20	614.66	0.24%	NY [*] YR	28	nup358
11	702.22	701.78	0.06%	VQE [*] AAQK	29	nup358
16	938.37	939.10	0.08%	EVADCFK	30	nup358
17	2459.64	2458.54	0.04%	<u>HDGTGGQSIYGDKFEDENFDVK</u> ^{**}	31	nup358
21	1419.00	1419.71	0.05%	<u>ITMELEXNIVPR</u> ^{**}	32	nup358
21	2773.58	2771.11	0.09%	<u>HTGPGLLSMANQGQNTNNXXFVIXLK</u> ^{**}	33	nup358

* Denotes a peptide that appeared in two adjacent HPLC fractions

** Underlining reflects sequences confirmed by Edman degradation

The third polypeptide identified in the CvC-5 gel spot is a fragment of lamin A (Fisher *et al.* (1986), *supra*; GenBank Accession #M13452). Two sequences matching lamin A were obtained by Edman degradation (Table 8). Nine additional masses from fragments of the CvC-5 tryptic map match predicted masses of tryptic fragments from lamin A. Mass correlation data for these additional masses were shown in Table 8. The amino acid sequence for this protein, (Fisher *et al.* (1986) *supra*), is shown in SEQ. ID No.: 46.

Table 8. Mass Correlation of CvC-5 derived Tryptic Peptides.

<u>Peak</u>	<u>Observed Mass (Da)</u>	<u>Predicted Mass (Da)</u>	<u>Delta</u>	<u>Sequence</u>	<u>Seq. ID No.</u>	<u>Protein</u>
7	667.10	666.69	0.06%	EFESR	35	lamin A
8	569.50	568.63	0.15%	TYSAK*	36	lamin A
8	585.78	587.63	0.31%	LDNAR	37	lamin A
11	569.10	568.63	0.08%	TYSAK*	38	lamin A
11	1025.18	1023.11	0.20%	NIYSEELR	39	lamin A
12	805.83	803.91	0.24%	TALSEKR	40	lamin A
17	1349.52	1347.56	0.15%	<u>LALDMEIHAYR</u> **	41	lamin A
17	1009.78	1009.18	0.06%	EMAEMRAR	42	lamin A
21	1912.74	1913.07	0.02%	EELDFQKNIYSEELR*	43	lamin A
22	1896.58	1894.13	0.13%	<u>MQOQLDEYQELLDIK</u> **	44	lamin A
22	1913.03	1913.07	0.00%	EELDFQKNIYSEELR*	45	lamin A

* Denotes a peptide that appeared in two adjacent HPLC fractions

** Underlining reflects sequences confirmed by Edman degradation

Cervical cancer-associated proteins may be identified using well-known techniques based upon the partial amino acid sequences provided above. Thus, the cervical cancer-associated proteins detected according to methods of the invention may be referred to as comprising a continuous sequence shown in the above-noted sequence fragments. It is appreciated that the skilled artisan, in view of the foregoing disclosure, would be able to produce an antibody directed against any cervical cancer-associated protein identified by the methods described herein. Moreover, the skilled artisan, in view of the foregoing disclosure, would be able to produce nucleic acid sequences which encode the fragments described above, as well as nucleic acid sequences complementary thereto. In addition, the skilled artisan using conventional recombinant DNA methodologies, for example, by screening a cDNA library with such a nucleic acid sequence, would be able to isolate full length nucleic acid sequences encoding target

cervical cancer-associated proteins. Such full length nucleic acid sequences, or fragments thereof, may be used to generate nucleic acid-based detection systems or therapeutics.

Example 4

Production of Antibodies Which Bind Specifically to Cervical Cancer-associated Proteins.

Once identified, a cervical cancer-associated protein, such as a CvC-1 through CvC-5, may be detected in a tissue or body fluid sample using numerous binding assays that are well known to those of ordinary skill in the art. For example, as discussed above, a cervical cancer-associated protein may be detected in either a tissue or body fluid sample using an antibody, for example, a monoclonal antibody, which bind specifically to an epitope disposed upon the cervical cancer-associated protein. In such detection systems, the antibody preferably is labeled with a detectable moiety.

Provided below is an exemplary protocol for the production of an anti-cervical cancer-associated monoclonal antibody. Other protocols also are envisioned. Accordingly, the particular method of producing antibodies to target proteins is not envisioned to be an aspect of the invention.

Balb/c by J mice (Jackson Laboratory, Bar Harbor, ME) are injected intraperitoneally with the target protein, e.g., CvC-3 protein isolated from HeLa cell nuclear matrix, every 2 weeks until the immunized mice obtain the appropriate serum titer. Thereafter, the mice are injected with 3 consecutive intravenous boosts. Freund's complete adjuvant (Gibco, Grand Island) is used in the first injection, incomplete Freund's in the second injection; and saline is used for subsequent intravenous injections. The animal is then sacrificed and its spleen removed. Spleen cells (or lymph node cells) then are fused with a mouse myeloma line, e.g., using the method of Kohler *et al.* (1975) *Nature* 256: 495, the disclosure of which is incorporated herein by reference. Hybridomas producing antibodies that react with the target proteins then are cloned and grown as ascites. Hybridomas are screened by nuclear reactivity against the cell line that is the source of

the immunogen, and by tissue immunohistochemistry using standard procedures known in the immunology art. Detailed descriptions of screening protocols, ascites production and immunoassays also are disclosed in PCT/US92/09220 published May 13, 1993, the disclosure of which is incorporated herein by reference.

5

Example 5

Antibody-based Assay for Detecting Cervical Cancer in an Individual.

The following assay has been developed for tissue samples, however, it is contemplated
10 that similar assays for testing fluid samples may be developed without undue experimentation. A typical assay may employ a commercial immunodetection kit, for example, the ABC Elite Kit from Vector Laboratories, Inc.

A biopsy sample, for example, a Pap smear is removed from the patient under
15 investigation in accordance with the appropriate medical guidelines. The sample then is applied to a glass microscope slide and the sample fixed in cold acetone for 10 minutes. Then, the slide is rinsed in distilled water and pretreated with a hydrogen peroxide containing solution (2 mL 30% H₂O₂ and 30 mL cold methanol). The slide is then rinsed in a Buffer A comprising Tris Buffered Saline (TBS) with 0.1% Tween and 0.1% Brij. A mouse anti-cervical cancer-
20 associated protein monoclonal antibody in Buffer A is added to the slide and the slide then is incubated for one hour at room temperature. The slide is then washed with Buffer A, and a secondary antibody (ABC Elite Kit, Vector Labs, Inc) in Buffer A is added to the slide. The slide is then incubated for 15 minutes at 37°C in a humidity chamber. The slides are washed again with Buffer A, and the ABC reagent (ABC Elite Kit, Vector Labs, Inc.) is then added to the
25 slide for amplification of the signal. The slide is then incubated for a further 15 minutes at 37°C in the humidity chamber.

The slide then is washed in distilled water, and a diaminobenzenedine (DAB) substrate added to the slide for 4-5 minutes. The slide is then rinsed with distilled water, counterstained

with hematoxylin, rinsed with 95% ethanol, rinsed with 100% ethanol, and then rinsed with xylene. A cover slip is then applied to the slide and the result observed by light microscopy.

Equivalents.

5

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The foregoing embodiments are therefore to be considered in all respects illustrative rather than limiting on the invention described herein. Scope of the invention is thus indicated by the appended claims rather than by the foregoing description, and
10 all changes that come within the meaning and range of equivalency of the claims are intended to be embraced therein.

54

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i) APPLICANT: KEESEE, SUSAN
OBAR, ROBERT
WU, YING-JYE

(ii) TITLE OF INVENTION: METHODS AND COMPOSITIONS FOR THE
DETECTION OF CERVICAL CANCER

(iii) NUMBER OF SEQUENCES: 46

(iv) CORRESPONDENCE ADDRESS:

(A) ADDRESSEE: Testa, Hurwitz & Thibault
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(C) CITY: Boston
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(F) ZIP: 02110

(v) COMPUTER READABLE FORM:

(A) MEDIUM TYPE: Floppy disk
(B) COMPUTER: IBM PC compatible
(C) OPERATING SYSTEM: PC-DOS/MS-DOS
(D) SOFTWARE: PatentIn Release #1.0, Version #1.30

(vi) CURRENT APPLICATION DATA:

(A) APPLICATION NUMBER:
(B) FILING DATE:
(C) CLASSIFICATION:

(viii) ATTORNEY/AGENT INFORMATION:

(A) NAME: GREENHALGH, DUNCAN A
(B) REGISTRATION NUMBER: 38,678
(C) REFERENCE/DOCKET NUMBER: MTP-023 (8395/27)

(ix) TELECOMMUNICATION INFORMATION:

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(B) TELEFAX: (617) 248-7100

(2) INFORMATION FOR SEQ ID NO:1:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 11 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

Pro Ala Ala Ser Leu Ala Val His Thr Asp Lys
1 5 10

(2) INFORMATION FOR SEQ ID NO:2:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 7 amino acids
(B) TYPE: amino acid

(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

Phe Ser Gly Gln Ile Glu Arg
1 5

(2) INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 9 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

Arg Leu Ile Ala Glu Ala Lys Glu Lys
1 5

(2) INFORMATION FOR SEQ ID NO:4:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 9 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

Pro Ser Leu Val His Ser Arg Asp Met
1 5

(2) INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 16 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

Val Trp Asp Ile Ser Thr Val Ser Ser Val Asn Glu Ala Phe Gly Arg
1 5 10 15

(2) INFORMATION FOR SEQ ID NO:6:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 18 amino acids
(B) TYPE: amino acid

(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

Leu Val Leu Gly Ser Ala Arg Asn Ser Ser Ile Ser Gly Pro Phe Gly
1 5 10 15
Ser Arg

(2) INFORMATION FOR SEQ ID NO:7:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 25 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

Ser Asp Lys Pro Ile Phe Thr Leu Asn Ala His Asn Asp Glu Ile Ser
1 5 10 15
Gly Leu Asp Leu Ser Ser Gln Ile Lys
20 25

(2) INFORMATION FOR SEQ ID NO:8:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 21 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

Val Gln Thr Leu Gln Phe His Pro Phe Glu Ala Gln Thr Leu Ile Ser
1 5 10 15
Gly Ser Tyr Asp Lys
20

(2) INFORMATION FOR SEQ ID NO:9:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 23 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

Met Gly Val Leu Phe Cys Ser Ser Cys Cys Pro Asp Leu Pro Phe Ile
 1 5 10 15

Tyr Ala Phe Gly Gly Gln Lys
 20

(2) INFORMATION FOR SEQ ID NO:10:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 501 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

Met Asn Arg Ser Arg Gln Val Thr Cys Val Ala Trp Val Arg Cys Gly
 1 5 10 15
 Val Ala Lys Glu Thr Pro Asp Lys Val Glu Leu Ser Lys Glu Glu Val
 20 25 30
 Lys Arg Leu Ile Ala Glu Ala Lys Glu Lys Leu Gln Glu Glu Gly Gly
 35 40 45
 Gly Ser Asp Glu Glu Glu Thr Gly Ser Pro Ser Glu Asp Gly Met Gln
 50 55 60
 Ser Ala Arg Thr Gln Ala Arg Pro Arg Glu Pro Leu Glu Asp Gly Asp
 65 70 75 80
 Pro Glu Asp Asp Arg Thr Leu Asp Asp Asp Glu Leu Ala Glu Tyr Asp
 85 90 95
 Leu Asp Lys Tyr Asp Glu Glu Gly Asp Pro Asp Ala Glu Thr Leu Gly
 100 105 110
 Glu Ser Leu Leu Gly Leu Thr Val Tyr Gly Ser Asn Asp Gln Asp Pro
 115 120 125
 Tyr Val Thr Leu Lys Asp Thr Glu Gln Tyr Glu Arg Glu Asp Phe Leu
 130 135 140
 Ile Lys Pro Ser Asp Asn Leu Ile Val Cys Gly Arg Ala Glu Gln Asp
 145 150 155 160
 Gln Cys Asn Leu Glu Val His Val Tyr Asn Gln Glu Glu Asp Ser Phe
 165 170 175
 Tyr Val His His Asp Ile Leu Leu Ser Ala Tyr Pro Leu Ser Val Glu
 180 185 190
 Trp Leu Asn Phe Asp Pro Ser Pro Asp Asp Ser Thr Gly Asn Tyr Ile
 195 200 205
 Ala Val Gly Asn Met Thr Pro Val Ile Glu Val Trp Asp Leu Asp Ile
 210 215 220
 Val Asp Ser Leu Glu Pro Val Phe Thr Leu Gly Ser Lys Leu Ser Lys
 225 230 235 240

Lys Lys Lys Lys Lys Gly Lys Lys Ser Ser Ser Ala Glu Gly His Thr
 245 250 255
 Asp Ala Val Leu Asp Leu Ser Trp Asn Lys Leu Ile Arg Asn Val Leu
 260 265 270
 Ala Ser Ala Ser Ala Asp Asn Thr Val Ile Leu Trp Asp Met Ser Leu
 275 280 285
 Gly Lys Pro Ala Ala Ser Leu Ala Val His Thr Asp Lys Val Gln Thr
 290 295 300
 Leu Gln Phe His Pro Phe Glu Ala Gln Thr Leu Ile Ser Gly Ser Tyr
 305 310 315 320
 Asp Lys Ser Val Ala Leu Tyr Asp Cys Arg Ser Pro Asp Glu Ser His
 325 330 335
 Arg Met Trp Arg Phe Ser Gly Gln Ile Glu Arg Val Thr Trp Asn His
 340 345 350
 Phe Ser Pro Cys His Phe Leu Ala Ser Thr Asp Asp Gly Phe Val Tyr
 355 360 365
 Asn Leu Asp Ala Arg Ser Asp Lys Pro Ile Phe Thr Leu Asn Ala His
 370 375 380
 Asn Asp Glu Ile Ser Gly Leu Asp Leu Ser Ser Gln Ile Lys Gly Cys
 385 390 395 400
 Leu Val Thr Ala Ser Ala Asp Lys Tyr Val Lys Ile Trp Asp Ile Leu
 405 410 415
 Gly Asp Arg Pro Ser Leu Val His Ser Arg Asp Met Lys Met Gly Val
 420 425 430
 Leu Phe Cys Ser Ser Cys Cys Pro Asp Leu Pro Phe Ile Tyr Ala Phe
 435 440 445
 Gly Gly Gln Lys Glu Gly Leu Arg Val Trp Asp Ile Ser Thr Val Ser
 450 455 460
 Ser Val Asn Glu Ala Phe Gly Arg Arg Glu Arg Leu Val Leu Gly Ser
 465 470 475 480
 Ala Arg Asn Ser Ser Ile Ser Gly Pro Phe Gly Ser Arg Ser Ser Asp
 485 490 495
 Thr Pro Met Glu Ser
 500

(2) INFORMATION FOR SEQ ID NO:11:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 7 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS:
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

Asp Tyr Ser Gln Tyr Tyr Arg
1 5

5 (2) INFORMATION FOR SEQ ID NO:12:

- (i) SEQUENCE CHARACTERISTICS:
10 (A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

15 (xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

Asn His Glu Glu Glu Met Asn Ala Leu Arg
1 5 10

20 (2) INFORMATION FOR SEQ ID NO:13:

- (i) SEQUENCE CHARACTERISTICS:
25 (A) LENGTH: 13 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

30 (ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

35 Leu Leu Glu Gly Glu Asp Ala His Leu Thr Gln Tyr Lys
1 5 10

(2) INFORMATION FOR SEQ ID NO:14:

- (i) SEQUENCE CHARACTERISTICS:
40 (A) LENGTH: 6 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

45 (ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

50 Ile Leu Asn Glu Met Arg
1 5

(2) INFORMATION FOR SEQ ID NO:15:

- 55 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

60 (ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

65 Ser Glu Ile Ser Glu Leu Arg
1 5

(2) INFORMATION FOR SEQ ID NO:16:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 9 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:16:

Asp Ala Glu Asp Trp Phe Phe Ser Lys
1 5

(2) INFORMATION FOR SEQ ID NO:17:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 11 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:17:

Leu Ser Val Glu Ala Asp Ile Asn Gly Leu Arg
1 5 10

(2) INFORMATION FOR SEQ ID NO:18:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 432 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:18:

Met Thr Thr Ser Ile Arg Gln Phe Thr Ser Ser Ser Ser Ile Lys Gly
1 5 10 15
Ser Ser Gly Leu Gly Gly Gly Ser Ser Arg Thr Ser Cys Arg Leu Ser
20 25 30
Gly Gly Leu Gly Ala Gly Ser Cys Arg Leu Gly Ser Ala Gly Gly Leu
35 40 45
Gly Ser Thr Leu Gly Gly Ser Ser Tyr Ser Ser Cys Tyr Ser Phe Gly
50 55 60
Ser Gly Gly Gly Tyr Gly Ser Ser Phe Gly Gly Val Asp Gly Leu Leu
65 70 75 80
Ala Gly Gly Glu Lys Ala Thr Met Gln Asn Leu Asn Asp Arg Leu Ala
85 90 95

Ser Tyr Leu Asp Lys Val Arg Ala Leu Glu Glu Ala Asn Thr Glu Leu
 100 105 110
 5 Glu Val Lys Ile Arg Asp Trp Tyr Gln Arg Gln Ala Pro Gly Pro Ala
 115 120 125
 Arg Asp Tyr Ser Gln Tyr Tyr Arg Thr Ile Glu Glu Leu Gln Asn Lys
 130 135 140
 10 Ile Leu Thr Ala Thr Val Asp Asn Ala Asn Ile Leu Leu Gln Ile Asp
 145 150 155 160
 Asn Ala Arg Leu Ala Ala Asp Asp Phe Arg Thr Lys Phe Glu Thr Glu
 165 170 175
 15 Gln Ala Leu Arg Leu Ser Val Glu Ala Asp Ile Asn Gly Leu Arg Arg
 180 185 190
 20 Val Leu Asp Glu Leu Thr Leu Ala Arg Ala Asp Leu Glu Met Gln Ile
 195 200 205
 Glu Asn Leu Lys Glu Glu Leu Ala Tyr Leu Lys Lys Asn His Glu Glu
 210 215 220
 25 Glu Met Asn Ala Leu Arg Gly Gln Val Gly Gly Glu Ile Asn Val Glu
 225 230 235 240
 Met Asp Ala Ala Pro Gly Val Asp Leu Ser Arg Ile Leu Asn Glu Met
 245 250 255
 30 Arg Asp Gln Tyr Glu Lys Met Ala Glu Lys Asn Arg Lys Asp Ala Glu
 260 265 270
 Asp Trp Phe Phe Ser Lys Thr Glu Glu Leu Asn Arg Glu Val Ala Thr
 275 280 285
 35 Asn Ser Glu Leu Val Gln Ser Gly Lys Ser Glu Ile Ser Glu Leu Arg
 290 295 300
 40 Arg Thr Met Gln Ala Leu Glu Ile Glu Leu Gln Ser Gln Leu Ser Met
 305 310 315 320
 Lys Ala Ser Leu Glu Gly Asn Leu Ala Glu Thr Glu Asn Arg Tyr Cys
 325 330 335
 45 Val Gln Leu Ser Gln Ile Gln Gly Leu Ile Gly Ser Val Glu Glu Gln
 340 345 350
 50 Leu Ala Gln Leu Arg Cys Glu Met Glu Gln Gln Asn Gln Glu Tyr Lys
 355 360 365
 Ile Leu Leu Asp Val Lys Thr Arg Leu Glu Gln Glu Ile Ala Thr Tyr
 370 375 380
 55 Arg Arg Leu Leu Glu Gly Glu Asp Ala His Leu Thr Gln Tyr Lys Lys
 385 390 395 400
 Glu Pro Val Thr Thr Arg Gln Val Arg Thr Ile Val Glu Glu Val Gln
 405 410 415
 60 Asp Gly Lys Val Ile Ser Ser Arg Glu Gln Val His Gln Thr Thr Arg
 420 425 430

(2) INFORMATION FOR SEQ ID NO:19:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 18 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:19:

Phe Gly Gly Asn Pro Gly Gly Phe Gly Asn Gln Gly Gly Phe Gly Asn
1 5 10 15
Ser Arg

(2) INFORMATION FOR SEQ ID NO:20:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 5 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:20:

Trp Cys Asp Cys Lys
1 5

(2) INFORMATION FOR SEQ ID NO:21:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 7 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:21:

Thr Thr Glu Gln Asp Leu Lys
1 5

(2) INFORMATION FOR SEQ ID NO:22:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 6 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:22:

Gly Phe Gly Phe Val Arg
1 5

(2) INFORMATION FOR SEQ ID NO:23:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 13 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:23:

Leu Pro Asn Ser Lys Gln Ser Gln Asp Glu Pro Leu Arg
1 5 10

(2) INFORMATION FOR SEQ ID NO:24:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 12 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:24:

Lys Met Asp Glu Thr Asp Ala Ser Ser Ala Val Lys
1 5 10

(2) INFORMATION FOR SEQ ID NO:25:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 12 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:25:

Thr Ser Asp Leu Ile Val Leu Gly Leu Pro Trp Lys
1 5 10

(2) INFORMATION FOR SEQ ID NO:26:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 414 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:26:

Met Ser Glu Tyr Ile Arg Val Thr Glu Asp Glu Asn Asp Glu Pro Ile
1 5 10 15

	Glu	Ile	Pro	Ser	Glu	Asp	Asp	Gly	Thr	Val	Leu	Leu	Ser	Thr	Val	Thr	
				20					25					30			
5	Ala	Gln	Phe	Pro	Gly	Ala	Cys	Gly	Leu	Arg	Tyr	Arg	Asn	Pro	Val	Ser	
			35					40					45				
	Gln	Cys	Met	Arg	Gly	Val	Arg	Leu	Val	Glu	Gly	Ile	Leu	His	Ala	Pro	
		50					55					60					
10	Asp	Ala	Gly	Trp	Gly	Asn	Leu	Val	Tyr	Val	Val	Asn	Tyr	Pro	Lys	Asp	
	65					70					75					80	
	Asn	Lys	Arg	Lys	Met	Asp	Glu	Thr	Asp	Ala	Ser	Ser	Ala	Val	Lys	Val	
15					85					90					95		
	Lys	Arg	Ala	Val	Gln	Lys	Thr	Ser	Asp	Leu	Ile	Val	Leu	Gly	Leu	Pro	
				100					105					110			
20	Trp	Lys	Thr	Thr	Glu	Gln	Asp	Leu	Lys	Glu	Tyr	Phe	Ser	Thr	Phe	Gly	
			115					120					125				
	Glu	Val	Leu	Met	Val	Gln	Val	Lys	Lys	Asp	Leu	Lys	Thr	Gly	His	Ser	
		130					135					140					
25	Lys	Gly	Phe	Gly	Phe	Val	Arg	Phe	Thr	Glu	Tyr	Glu	Thr	Gln	Val	Lys	
	145					150					155					160	
	Val	Met	Ser	Gln	Arg	His	Met	Ile	Asp	Gly	Arg	Trp	Cys	Asp	Cys	Lys	
30					165					170					175		
	Leu	Pro	Asn	Ser	Lys	Gln	Ser	Gln	Asp	Glu	Pro	Leu	Arg	Ser	Arg	Lys	
				180					185					190			
35	Val	Phe	Val	Gly	Arg	Cys	Thr	Glu	Asp	Met	Thr	Glu	Asp	Glu	Leu	Arg	
			195					200					205				
	Glu	Phe	Phe	Ser	Gln	Tyr	Gly	Asp	Val	Met	Asp	Val	Phe	Ile	Pro	Lys	
		210					215					220					
40	Pro	Phe	Arg	Ala	Phe	Ala	Phe	Val	Thr	Phe	Ala	Asp	Asp	Gln	Ile	Ala	
	225					230					235					240	
	Gln	Ser	Leu	Cys	Gly	Glu	Asp	Leu	Ile	Ile	Lys	Gly	Ile	Ser	Val	His	
45				245						250					255		
	Ile	Ser	Asn	Ala	Glu	Pro	Lys	His	Asn	Ser	Asn	Arg	Gln	Leu	Glu	Arg	
				260					265					270			
50	Ser	Gly	Arg	Phe	Gly	Gly	Asn	Pro	Gly	Gly	Phe	Gly	Asn	Gln	Gly	Gly	
			275					280					285				
	Phe	Gly	Asn	Ser	Arg	Gly	Gly	Gly	Ala	Gly	Leu	Gly	Asn	Asn	Gln	Gly	
		290					295					300					
55	Ser	Asn	Met	Gly	Gly	Gly	Met	Asn	Phe	Gly	Ala	Phe	Ser	Ile	Asn	Pro	
	305					310					315					320	
	Ala	Met	Met	Ala	Ala	Ala	Gln	Ala	Ala	Leu	Gln	Ser	Ser	Trp	Gly	Met	
60					325					330					335		
	Met	Gly	Met	Leu	Ala	Ser	Gln	Gln	Asn	Gln	Ser	Gly	Pro	Ser	Gly	Asn	
				340					345					350			
65	Asn	Gln	Asn	Gln	Gly	Asn	Met	Gln	Arg	Glu	Pro	Asn	Gln	Ala	Phe	Gly	
		355						360					365				

Ser Gly Asn Asn Ser Tyr Ser Gly Ser Asn Ser Gly Ala Ala Ile Gly
370 375 380

Trp Gly Ser Ala Ser Asn Ala Gly Ser Gly Ser Gly Phe Asn Gly Gly
385 390 395 400

Phe Gly Ser Ser Met Asp Ser Lys Ser Ser Gly Trp Gly Met
405 410

(2) INFORMATION FOR SEQ ID NO:27:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 4 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:27:

Asn Tyr Tyr Arg
1

(2) INFORMATION FOR SEQ ID NO:28:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 4 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:28:

Asn Tyr Tyr Arg
1

(2) INFORMATION FOR SEQ ID NO:29:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 6 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:29:

Val Gln Glu Ala Gln Lys
1 5

(2) INFORMATION FOR SEQ ID NO:30:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:30:

Glu Val Ala Asp Cys Phe Lys
1 5

(2) INFORMATION FOR SEQ ID NO:31:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 22 amino acids

(B) TYPE: amino acid

(C) STRANDEDNESS:

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:31:

His Asp Gly Thr Gly Gly Gln Ser Ile Tyr Gly Asp Lys Phe Glu Asp
1 5 10 15

Glu Asn Phe Asp Val Lys
20

(2) INFORMATION FOR SEQ ID NO:32:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 12 amino acids

(B) TYPE: amino acid

(C) STRANDEDNESS:

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:32:

Ile Thr Met Glu Leu Phe Xaa Asn Ile Val Pro Arg
1 5 10

(2) INFORMATION FOR SEQ ID NO:33:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 26 amino acids

(B) TYPE: amino acid

(C) STRANDEDNESS:

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:33:

His Thr Gly Pro Gly Leu Leu Ser Met Ala Asn Gln Gly Gln Asn Thr
1 5 10 15

Asn Asn Xaa Xaa Phe Val Ile Xaa Leu Lys
20 25

(2) INFORMATION FOR SEQ ID NO:34:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 3224 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:34:

Met Arg Arg Ser Lys Ala Asp Val Glu Arg Tyr Ile Ala Ser Val Gln
1 5 10 15
Gly Ser Thr Pro Ser Pro Arg Gln Lys Ser Met Lys Gly Phe Tyr Phe
20 25 30
Ala Lys Leu Tyr Tyr Glu Ala Lys Glu Tyr Asp Leu Ala Lys Lys Tyr
35 40 45
Ile Cys Thr Tyr Ile Asn Val Gln Glu Arg Asp Pro Lys Ala His Arg
50 55 60
Phe Leu Gly Leu Leu Tyr Glu Leu Glu Glu Asn Thr Asp Lys Ala Val
65 70 75 80
Glu Cys Tyr Arg Arg Ser Val Glu Leu Asn Pro Thr Gln Lys Asp Leu
85 90 95
Val Leu Lys Ile Ala Glu Leu Leu Cys Lys Asn Asp Val Thr Asp Gly
100 105 110
Arg Ala Lys Tyr Trp Leu Glu Arg Ala Ala Lys Leu Phe Pro Gly Ser
115 120 125
Pro Ala Ile Tyr Lys Leu Lys Glu Gln Leu Leu Asp Cys Glu Gly Glu
130 135 140
Asp Gly Trp Asn Lys Leu Phe Asp Leu Ile Gln Ser Glu Leu Tyr Val
145 150 155 160
Arg Pro Asp Asp Val His Val Asn Ile Arg Leu Val Glu Val Tyr Arg
165 170 175
Ser Thr Lys Arg Leu Lys Asp Ala Val Ala His Cys His Glu Ala Glu
180 185 190
Arg Asn Ile Ala Leu Arg Ser Ser Leu Glu Trp Asn Ser Cys Val Val
195 200 205
Gln Thr Leu Lys Glu Tyr Leu Glu Ser Leu Gln Cys Leu Glu Ser Asp
210 215 220
Lys Ser Asp Trp Arg Ala Thr Asn Thr Asp Leu Leu Leu Ala Tyr Ala
225 230 235 240
Asn Leu Met Leu Leu Thr Leu Ser Thr Arg Asp Val Gln Glu Ser Arg
245 250 255
Glu Leu Leu Gln Ser Phe Asp Ser Ala Leu Gln Ser Val Lys Ser Leu
260 265 270
Gly Gly Asn Asp Glu Leu Ser Ala Thr Phe Leu Glu Met Lys Gly His
275 280 285

Phe Tyr Met His Ala Gly Ser Leu Leu Leu Lys Met Gly Gln His Ser
 290 295 300
 5 Ser Asn Val Gln Trp Arg Ala Leu Ser Glu Leu Ala Ala Leu Cys Tyr
 305 310 315 320
 Leu Ile Ala Phe Gln Val Pro Arg Pro Lys Ile Lys Leu Ile Lys Gly
 325 330 335
 10 Glu Ala Gly Gln Asn Leu Leu Glu Met Met Ala Cys Asp Arg Leu Ser
 340 345 350
 15 Gln Ser Gly His Met Leu Leu Asn Leu Ser Arg Gly Lys Gln Asp Phe
 355 360 365
 Leu Lys Glu Ile Val Glu Thr Phe Ala Asn Lys Ser Gly Gln Ser Ala
 370 375 380
 20 Leu Tyr Asp Ala Leu Phe Ser Ser Gln Ser Pro Lys Asp Thr Ser Phe
 385 390 395 400
 Leu Gly Ser Asp Asp Ile Gly Asn Ile Asp Val Arg Glu Pro Glu Leu
 405 410 415
 25 Glu Asp Leu Thr Arg Tyr Asp Val Gly Ala Ile Arg Ala His Asn Gly
 420 425 430
 30 Ser Leu Gln His Leu Thr Trp Leu Gly Leu Gln Trp Asn Ser Leu Pro
 435 440 445
 Ala Leu Pro Gly Ile Arg Lys Trp Leu Lys Gln Leu Phe His His Leu
 450 455 460
 35 Pro His Glu Thr Ser Arg Leu Glu Thr Asn Ala Pro Glu Ser Ile Cys
 465 470 475 480
 Ile Leu Asp Leu Glu Val Phe Leu Leu Gly Val Val Tyr Thr Ser His
 485 490 495
 40 Leu Gln Leu Lys Glu Lys Cys Asn Ser His His Ser Ser Tyr Gln Pro
 500 505 510
 45 Leu Cys Leu Pro Leu Pro Val Cys Lys Gln Leu Cys Thr Glu Arg Gln
 515 520 525
 Lys Ser Trp Trp Asp Ala Val Cys Thr Leu Ile His Arg Lys Ala Val
 530 535 540
 50 Pro Gly Asn Val Ala Lys Leu Arg Leu Leu Val Gln His Glu Ile Asn
 545 550 555 560
 Thr Leu Arg Ala Gln Glu Lys His Gly Leu Gln Pro Ala Leu Leu Val
 565 570 575
 55 His Trp Ala Glu Cys Leu Gln Lys Thr Gly Ser Gly Leu Asn Ser Phe
 580 585 590
 60 Tyr Asp Gln Arg Glu Tyr Ile Gly Arg Ser Val His Tyr Trp Lys Lys
 595 600 605
 Val Leu Pro Leu Leu Lys Ile Ile Lys Lys Lys Asn Ser Ile Pro Glu
 610 615 620

	Pro	Ile	Asp	Pro	Leu	Phe	Lys	His	Phe	His	Ser	Val	Asp	Ile	Gln	Ala	
	625					630					635					640	
5	Ser	Glu	Ile	Val	Glu	Tyr	Glu	Glu	Asp	Ala	His	Ile	Thr	Phe	Ala	Ile	
					645					650					655		
	Leu	Asp	Ala	Val	Asn	Gly	Asn	Ile	Glu	Asp	Ala	Val	Thr	Ala	Phe	Glu	
				660					665					670			
10	Ser	Ile	Lys	Ser	Val	Val	Ser	Tyr	Trp	Asn	Leu	Ala	Leu	Ile	Phe	His	
			675					680					685				
	Arg	Lys	Ala	Glu	Asp	Ile	Glu	Asn	Asp	Ala	Leu	Ser	Pro	Glu	Glu	Gln	
15		690					695				700						
	Glu	Glu	Cys	Lys	Asn	Tyr	Leu	Arg	Lys	Thr	Arg	Asp	Tyr	Leu	Ile	Lys	
	705				710						715					720	
20	Ile	Ile	Asp	Asp	Ser	Asp	Ser	Asn	Leu	Ser	Val	Val	Lys	Lys	Leu	Pro	
					725					730					735		
	Val	Pro	Leu	Glu	Ser	Val	Lys	Glu	Met	Leu	Asn	Ser	Val	Met	Gln	Glu	
				740					745					750			
25	Leu	Glu	Asp	Tyr	Ser	Glu	Gly	Gly	Pro	Leu	Tyr	Lys	Asn	Gly	Ser	Leu	
			755					760					765				
	Arg	Asn	Ala	Asp	Ser	Glu	Ile	Lys	Arg	Ser	Thr	Pro	Ser	Pro	Thr	Arg	
30		770					775					780					
	Tyr	Ser	Leu	Ser	Pro	Ser	Lys	Ser	Tyr	Lys	Tyr	Ser	Pro	Lys	Thr	Pro	
	785					790					795					800	
35	Pro	Arg	Trp	Ala	Glu	Asp	Gln	Asn	Ser	Leu	Leu	Lys	Met	Ile	Cys	Gln	
					805					810					815		
	Gln	Val	Glu	Ala	Ile	Lys	Lys	Glu	Met	Gln	Glu	Leu	Lys	Leu	Asn	Ser	
				820					825					830			
40	Ser	Asn	Ser	Ala	Ser	Pro	His	Arg	Trp	Pro	Thr	Glu	Asn	Tyr	Gly	Pro	
			835					840					845				
	Asp	Ser	Val	Pro	Asp	Gly	Tyr	Gln	Gly	Ser	Gln	Thr	Phe	His	Gly	Ala	
45		850					855					860					
	Pro	Leu	Thr	Val	Ala	Thr	Thr	Gly	Pro	Ser	Val	Tyr	Tyr	Ser	Gln	Ser	
	865					870					875					880	
50	Pro	Ala	Tyr	Asn	Ser	Gln	Tyr	Leu	Leu	Arg	Pro	Ala	Ala	Asn	Val	Thr	
					885					890					895		
	Pro	Thr	Lys	Gly	Pro	Val	Tyr	Gly	Met	Asn	Arg	Leu	Pro	Pro	Gln	Gln	
				900					905						910		
55	His	Ile	Tyr	Ala	Tyr	Pro	Gln	Gln	Met	His	Thr	Pro	Pro	Val	Gln	Ser	
			915					920					925				
	Ser	Ser	Ala	Cys	Met	Phe	Ser	Gln	Glu	Met	Tyr	Gly	Pro	Pro	Ala	Leu	
60		930					935					940					
	Arg	Phe	Glu	Ser	Pro	Ala	Thr	Gly	Ile	Leu	Ser	Pro	Arg	Gly	Asp	Asp	
	945					950					955					960	
65	Tyr	Phe	Asn	Tyr	Asn	Val	Gln	Gln	Thr	Ser	Thr	Asn	Pro	Pro	Leu	Pro	
					965					970					975		

Glu Pro Gly Tyr Phe Thr Lys Pro Pro Ile Ala Ala His Ala Ser Arg
 980 985 990

Ser Ala Glu Ser Lys Thr Ile Glu Phe Gly Lys Thr Asn Phe Val Gln
 995 1000 1005

Pro Met Pro Gly Glu Gly Leu Arg Pro Ser Leu Pro Thr Gln Ala His
 1010 1015 1020

Thr Thr Gln Pro Thr Pro Phe Lys Phe Asn Ser Asn Phe Lys Ser Asn
 1025 1030 1035 1040

Asp Gly Asp Phe Thr Phe Ser Ser Pro Gln Val Val Thr Gln Pro Pro
 1045 1050 1055

Pro Ala Ala Tyr Ser Asn Ser Glu Ser Leu Leu Gly Leu Leu Thr Ser
 1060 1065 1070

Asp Lys Pro Leu Gln Gly Asp Gly Tyr Ser Gly Ala Lys Pro Ile Pro
 1075 1080 1085

Gly Gly Gln Thr Ile Gly Pro Arg Asn Thr Phe Asn Phe Gly Ser Lys
 1090 1095 1100

Asn Val Ser Gly Ile Ser Phe Thr Glu Asn Met Gly Ser Ser Gln Gln
 1105 1110 1115 1120

Lys Asn Ser Gly Phe Arg Arg Ser Asp Asp Met Phe Thr Phe His Gly
 1125 1130 1135

Pro Gly Lys Ser Val Phe Gly Thr Pro Thr Leu Glu Thr Ala Asn Lys
 1140 1145 1150

Asn His Glu Thr Asp Gly Gly Ser Ala His Gly Asp Asp Asp Asp
 1155 1160 1165

Gly Pro His Phe Glu Pro Val Val Pro Leu Pro Asp Lys Ile Glu Val
 1170 1175 1180

Lys Thr Gly Glu Glu Asp Glu Glu Glu Phe Phe Cys Asn Arg Ala Lys
 1185 1190 1195 1200

Leu Phe Arg Phe Asp Val Glu Ser Lys Glu Trp Lys Glu Arg Gly Ile
 1205 1210 1215

Gly Asn Val Lys Ile Leu Arg His Lys Thr Ser Gly Lys Ile Arg Leu
 1220 1225 1230

Leu Met Arg Arg Glu Gln Val Leu Lys Ile Cys Ala Asn His Tyr Ile
 1235 1240 1245

Ser Pro Asp Met Lys Leu Thr Pro Asn Ala Gly Ser Asp Arg Ser Phe
 1250 1255 1260

Val Trp His Ala Leu Asp Tyr Ala Asp Glu Leu Pro Lys Pro Glu Gln
 1265 1270 1275 1280

Leu Ala Ile Arg Phe Lys Thr Pro Glu Glu Ala Ala Leu Phe Lys Cys
 1285 1290 1295

Lys Phe Glu Glu Ala Gln Ser Ile Leu Lys Ala Pro Gly Thr Asn Val
 1300 1305 1310

Ala Met Ala Ser Asn Gln Ala Val Arg Ile Val Lys Glu Pro Thr Ser
1315 1320 1325

5 His Asp Asn Lys Asp Ile Cys Lys Ser Asp Ala Gly Asn Leu Asn Phe
1330 1335 1340

Glu Phe Gln Val Ala Lys Lys Glu Gly Ser Trp Trp His Cys Asn Ser
1345 1350 1355 1360

10 Cys Ser Leu Lys Asn Ala Ser Thr Ala Lys Lys Cys Val Ser Cys Gln
1365 1370 1375

Asn Leu Asn Pro Ser Asn Lys Glu Leu Val Gly Pro Pro Leu Ala Glu
1380 1385 1390

15 Thr Val Phe Thr Pro Lys Thr Ser Pro Glu Asn Val Gln Asp Arg Phe
1395 1400 1405

Ala Leu Val Thr Pro Lys Lys Glu Gly His Trp Asp Cys Ser Ile Cys
1410 1415 1420

20 Leu Val Arg Asn Glu Pro Thr Val Ser Arg Cys Ile Ala Cys Gln Asn
1425 1430 1435 1440

25 Thr Lys Ser Ala Asn Lys Ser Gly Ser Ser Phe Val His Gln Ala Ser
1445 1450 1455

Phe Lys Phe Gly Gln Gly Asp Leu Pro Lys Pro Ile Asn Ser Asp Phe
1460 1465 1470

30 Arg Ser Val Phe Ser Thr Lys Glu Gly Gln Trp Asp Cys Ser Ala Cys
1475 1480 1485

Leu Val Gln Asn Glu Gly Ser Ser Thr Lys Cys Ala Ala Cys Gln Asn
1490 1495 1500

35 Pro Arg Lys Gln Ser Leu Pro Ala Thr Ser Ile Pro Thr Pro Ala Ser
1505 1510 1515 1520

40 Phe Lys Phe Gly Thr Ser Glu Thr Ser Lys Thr Leu Lys Ser Gly Phe
1525 1530 1535

Glu Asp Met Phe Ala Lys Lys Glu Gly Gln Trp Asp Cys Ser Ser Cys
1540 1545 1550

45 Leu Val Arg Asn Glu Ala Asn Ala Thr Arg Cys Val Ala Cys Gln Asn
1555 1560 1565

Pro Asp Lys Pro Ser Pro Ser Thr Ser Val Pro Ala Pro Ala Ser Phe
1570 1575 1580

Lys Phe Gly Thr Ser Glu Thr Ser Lys Ala Pro Lys Ser Gly Phe Glu
1585 1590 1595 1600

55 Gly Met Phe Thr Lys Lys Glu Gly Gln Trp Asp Cys Ser Val Cys Leu
1605 1610 1615

Val Arg Asn Glu Ala Ser Ala Thr Lys Cys Ile Ala Cys Gln Asn Pro
1620 1625 1630

60 Gly Lys Gln Asn Gln Thr Thr Ser Ala Val Ser Thr Pro Ala Ser Ser
1635 1640 1645

Glu Thr Ser Lys Ala Pro Lys Ser Gly Phe Glu Gly Met Phe Thr Lys
1650 1655 1660

Lys Glu Gly Gln Trp Asp Cys Ser Val Cys Leu Val Arg Asn Glu Ala
 1665 1670 1675 1680

Ser Ala Thr Lys Cys Ile Ala Cys Gln Asn Pro Gly Lys Gln Asn Gln
 1685 1690 1695

Thr Thr Ser Ala Val Ser Thr Pro Ala Ser Ser Glu Thr Ser Lys Ala
 1700 1705 1710

Pro Lys Ser Gly Phe Glu Gly Met Phe Thr Lys Lys Glu Gly Gln Trp
 1715 1720 1725

Asp Cys Ser Val Cys Leu Val Arg Asn Glu Ala Ser Ala Thr Lys Cys
 1730 1735 1740

Ile Ala Cys Gln Cys Pro Ser Lys Gln Asn Gln Thr Thr Ala Ile Ser
 1745 1750 1755 1760

Thr Pro Ala Ser Ser Glu Ile Ser Lys Ala Pro Lys Ser Gly Phe Glu
 1765 1770 1775

Gly Met Phe Ile Arg Lys Gly Gln Trp Asp Cys Ser Val Cys Cys Val
 1780 1785 1790

Gln Asn Glu Ser Ser Ser Leu Lys Cys Val Ala Cys Asp Ala Ser Lys
 1795 1800 1805

Pro Thr His Lys Pro Ile Ala Glu Ala Pro Ser Ala Phe Thr Leu Gly
 1810 1815 1820

Ser Glu Met Lys Leu His Asp Ser Ser Gly Ser Gln Val Gly Thr Gly
 1825 1830 1835 1840

Phe Lys Ser Asn Phe Ser Glu Lys Ala Ser Lys Phe Gly Asn Thr Glu
 1845 1850 1855

Gln Gly Phe Lys Phe Gly His Val Asp Gln Glu Asn Ser Pro Ser Phe
 1860 1865 1870

Met Phe Gln Gly Ser Ser Asn Thr Glu Phe Lys Ser Thr Lys Glu Gly
 1875 1880 1885

Phe Ser Ile Pro Val Ser Ala Asp Gly Phe Lys Phe Gly Ile Ser Glu
 1890 1895 1900

Pro Gly Asn Gln Glu Lys Lys Ser Glu Lys Pro Leu Glu Asn Gly Thr
 1905 1910 1915 1920

Gly Phe Gln Ala Gln Asp Ile Ser Gly Gln Lys Asn Gly Arg Gly Val
 1925 1930 1935

Ile Phe Gly Gln Thr Ser Ser Thr Phe Thr Phe Ala Asp Leu Ala Lys
 1940 1945 1950

Ser Thr Ser Gly Glu Gly Phe Gln Phe Gly Lys Lys Asp Pro Asn Phe
 1955 1960 1965

Lys Gly Phe Ser Gly Ala Gly Glu Lys Leu Phe Ser Ser Gln Tyr Gly
 1970 1975 1980

Lys Met Ala Asn Lys Ala Asn Thr Ser Gly Asp Phe Glu Lys Asp Asp
 1985 1990 1995 2000

Asp Ala Tyr Lys Thr Glu Asp Ser Asp Asp Ile His Phe Glu Pro Val
 2005 2010 2015
 Val Gln Met Pro Glu Lys Val Glu Leu Val Thr Gly Glu Glu Asp Glu
 2020 2025 2030
 Lys Val Leu Tyr Ser Gln Arg Val Lys Leu Phe Arg Phe Asp Ala Glu
 2035 2040 2045
 Val Ser Gln Trp Lys Glu Arg Gly Leu Gly Asn Leu Lys Ile Leu Lys
 2050 2055 2060
 Asn Glu Val Asn Gly Lys Leu Arg Met Leu Met Arg Arg Glu Gln Val
 2065 2070 2075 2080
 Leu Lys Val Cys Ala Asn His Trp Ile Thr Thr Thr Met Asn Leu Lys
 2085 2090 2095
 Pro Leu Ser Gly Ser Asp Arg Ala Trp Met Trp Leu Ala Ser Asp Phe
 2100 2105 2110
 Ser Asp Gly Asp Ala Lys Leu Glu Gln Leu Ala Ala Lys Phe Lys Thr
 2115 2120 2125
 Pro Glu Leu Ala Glu Glu Phe Lys Gln Lys Phe Glu Glu Cys Gln Arg
 2130 2135 2140
 Leu Leu Leu Asp Ile Pro Leu Gln Thr Pro His Lys Leu Val Asp Thr
 2145 2150 2155 2160
 Gly Arg Ala Ala Lys Leu Ile Gln Arg Ala Glu Glu Met Lys Ser Gly
 2165 2170 2175
 Leu Lys Asp Phe Lys Thr Phe Leu Thr Asn Asp Gln Thr Lys Val Thr
 2180 2185 2190
 Glu Glu Glu Asn Lys Gly Ser Gly Thr Gly Ala Ala Gly Ala Ser Asp
 2195 2200 2205
 Thr Thr Ile Lys Pro Asn Pro Glu Asn Thr Gly Pro Thr Leu Glu Trp
 2210 2215 2220
 Asp Asn Tyr Asp Leu Arg Glu Asp Ala Leu Asp Asp Ser Val Ser Ser
 2225 2230 2235 2240
 Ser Ser Val His Ala Ser Pro Leu Ala Ser Ser Pro Val Arg Lys Asn
 2245 2250 2255
 Leu Phe Arg Phe Gly Glu Ser Thr Thr Gly Phe Asn Phe Ser Phe Lys
 2260 2265 2270
 Ser Ala Leu Ser Pro Ser Lys Ser Pro Ala Lys Leu Asn Gln Ser Gly
 2275 2280 2285
 Thr Ser Val Gly Thr Asp Glu Glu Ser Asp Val Thr Gln Glu Glu Glu
 2290 2295 2300
 Arg Asp Gly Gln Tyr Phe Glu Pro Val Val Pro Leu Pro Asp Leu Val
 2305 2310 2315 2320
 Glu Val Ser Ser Gly Glu Glu Asn Glu Gln Val Val Phe Ser His Arg
 2325 2330 2335
 Ala Lys Leu Tyr Arg Tyr Asp Lys Asp Val Gly Gln Trp Lys Glu Arg
 2340 2345 2350

Gly Ile Gly Asp Ile Lys Ile Leu Gln Asn Tyr Asp Asn Lys Gln Val
 2355 2360 2365

Arg Ile Val Met Arg Arg Asp Gln Val Leu Lys Leu Cys Ala Asn His
 2370 2375 2380

Arg Ile Thr Pro Asp Met Thr Leu Gln Asn Met Lys Gly Thr Glu Arg
 2385 2390 2395 2400

Val Trp Leu Trp Thr Ala Cys Asp Phe Ala Asp Gly Glu Arg Lys Val
 2405 2410 2415

Glu His Leu Ala Val Arg Phe Lys Leu Gln Asp Val Ala Asp Ser Phe
 2420 2425 2430

Lys Lys Ile Phe Asp Glu Ala Lys Thr Ala Gln Glu Lys Asp Ser Leu
 2435 2440 2445

Ile Thr Pro His Val Ser Arg Ser Ser Thr Pro Arg Glu Ser Pro Cys
 2450 2455 2460

Gly Lys Ile Ala Val Ala Val Leu Glu Glu Thr Thr Arg Glu Arg Thr
 2465 2470 2475 2480

Asp Val Ile Gln Gly Asp Asp Val Ala Asp Ala Thr Ser Glu Val Glu
 2485 2490 2495

Val Ser Ser Thr Ser Glu Thr Thr Pro Lys Ala Val Val Ser Pro Pro
 2500 2505 2510

Lys Phe Val Phe Gly Ser Glu Ser Val Lys Ser Ile Phe Ser Ser Glu
 2515 2520 2525

Lys Ser Lys Pro Phe Ala Phe Gly Asn Ser Ser Ala Thr Gly Ser Leu
 2530 2535 2540

Phe Gly Phe Ser Phe Asn Ala Pro Leu Lys Ser Asn Asn Ser Glu Thr
 2545 2550 2555 2560

Ser Ser Val Ala Gln Ser Gly Ser Glu Ser Lys Val Glu Pro Lys Lys
 2565 2570 2575

Cys Glu Leu Ser Lys Asn Ser Asp Ile Glu Gln Ser Ser Asp Ser Lys
 2580 2585 2590

Val Lys Asn Leu Phe Ala Ser Phe Pro Thr Glu Glu Ser Ser Ile Asn
 2595 2600 2605

Tyr Thr Phe Lys Thr Pro Glu Lys Ala Lys Glu Lys Lys Lys Pro Glu
 2610 2615 2620

Asp Ser Pro Ser Asp Asp Asp Val Leu Ile Val Tyr Glu Leu Thr Pro
 2625 2630 2635 2640

Thr Ala Glu Gln Lys Ala Leu Ala Thr Lys Leu Lys Leu Pro Pro Thr
 2645 2650 2655

Phe Phe Cys Tyr Lys Asn Arg Pro Asp Tyr Val Ser Glu Glu Glu Glu
 2660 2665 2670

Asp Asp Glu Asp Phe Glu Thr Ala Val Lys Lys Leu Asn Gly Lys Leu
 2675 2680 2685

Tyr Leu Asp Gly Ser Glu Lys Cys Arg Pro Leu Glu Glu Asn Thr Ala
 2690 2695 2700
 5 Asp Asn Glu Lys Glu Cys Ile Ile Val Trp Glu Lys Lys Pro Thr Val
 2705 2710 2715 2720
 Glu Glu Lys Ala Lys Ala Asp Thr Leu Lys Leu Pro Pro Thr Phe Phe
 2725 2730 2735
 10 Cys Gly Val Cys Ser Asp Thr Asp Glu Asp Asn Gly Asn Gly Glu Asp
 2740 2745 2750
 Phe Gln Ser Glu Leu Gln Lys Val Gln Glu Ala Gln Lys Ser Gln Thr
 2755 2760 2765
 15 Glu Glu Ile Thr Ser Thr Thr Asp Ser Val Tyr Thr Gly Gly Thr Glu
 2770 2775 2780
 20 Val Met Val Pro Ser Phe Cys Lys Ser Glu Glu Pro Asp Ser Ile Thr
 2785 2790 2795 2800
 Lys Ser Ile Ser Ser Pro Ser Val Ser Ser Glu Thr Met Asp Lys Pro
 2805 2810 2815
 25 Val Asp Leu Ser Thr Arg Lys Glu Ile Asp Thr Asp Ser Thr Ser Gln
 2820 2825 2830
 Gly Glu Ser Lys Ile Val Ser Phe Gly Phe Gly Ser Ser Thr Gly Leu
 2835 2840 2845
 30 Ser Phe Ala Asp Leu Ala Ser Ser Asn Ser Gly Asp Phe Ala Phe Gly
 2850 2855 2860
 35 Ser Lys Asp Lys Asn Phe Gln Trp Ala Asn Thr Gly Ala Ala Val Phe
 2865 2870 2875 2880
 Gly Thr Gln Ser Val Gly Thr Gln Ser Ala Gly Lys Val Gly Glu Asp
 2885 2890 2895
 40 Glu Asp Gly Ser Asp Glu Glu Val Val His Asn Glu Asp Ile His Phe
 2900 2905 2910
 Glu Pro Ile Val Ser Leu Pro Glu Val Glu Val Lys Ser Gly Glu Glu
 2915 2920 2925
 45 Asp Glu Glu Ile Leu Phe Lys Glu Arg Ala Lys Leu Tyr Arg Trp Asp
 2930 2935 2940
 50 Arg Asp Val Ser Gln Trp Lys Glu Arg Gly Val Gly Asp Ile Lys Ile
 2945 2950 2955 2960
 Leu Trp His Thr Met Lys Asn Tyr Tyr Arg Ile Leu Met Arg Arg Asp
 2965 2970 2975
 55 Gln Val Phe Lys Val Cys Ala Asn His Val Ile Thr Lys Thr Met Glu
 2980 2985 2990
 Leu Lys Pro Leu Asn Val Ser Asn Asn Ala Leu Val Trp Thr Ala Ser
 2995 3000 3005
 60 Asp Tyr Ala Asp Gly Glu Ala Lys Val Glu Gln Leu Ala Val Arg Phe
 3010 3015 3020
 65 Lys Thr Lys Glu Val Ala Asp Cys Phe Lys Lys Thr Phe Glu Glu Cys
 3025 3030 3035 3040

Gln Gln Asn Leu Met Lys Leu Gln Lys Gly His Val Ser Leu Ala Ala
3045 3050 3055

5 Glu Leu Ser Lys Glu Thr Asn Pro Val Val Phe Phe Asp Val Cys Ala
3060 3065 3070

10 Asp Gly Glu Pro Leu Gly Arg Ile Thr Met Glu Leu Phe Ser Asn Ile
3075 3080 3085

Val Pro Arg Thr Ala Glu Asn Phe Arg Ala Leu Cys Thr Gly Glu Lys
3090 3095 3100

15 Gly Phe Gly Phe Lys Asn Ser Ile Phe His Arg Val Ile Pro Asp Phe
3105 3110 3115 3120

Val Cys Gln Gly Gly Asp Ile Thr Lys His Asp Gly Thr Gly Gly Gln
3125 3130 3135

20 Ser Ile Tyr Gly Asp Lys Phe Glu Asp Glu Asn Phe Asp Val Lys His
3140 3145 3150

25 Thr Gly Pro Gly Leu Leu Ser Met Ala Asn Gln Gly Gln Asn Thr Asn
3155 3160 3165

Asn Ser Gln Phe Val Ile Thr Leu Lys Lys Ala Glu His Leu Asp Phe
3170 3175 3180

30 Lys His Val Val Phe Gly Phe Val Lys Asp Gly Met Asp Thr Val Lys
3185 3190 3195 3200

Lys Ile Glu Ser Phe Gly Ser Pro Lys Gly Ser Val Cys Arg Arg Ile
3205 3210 3215

35 Thr Ile Thr Glu Cys Gly Gln Ile
3220

(2) INFORMATION FOR SEQ ID NO:35:

- (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 5 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:35:

Glu Phe Glu Ser Arg
1 5

(2) INFORMATION FOR SEQ ID NO:36:

- (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 5 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:36:

Thr Tyr Ser Ala Lys
1 5

(2) INFORMATION FOR SEQ ID NO:37:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 5 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:37:

Leu Asp Asn Ala Arg
1 5

(2) INFORMATION FOR SEQ ID NO:38:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 5 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:38:

Thr Tyr Ser Ala Lys
1 5

(2) INFORMATION FOR SEQ ID NO:39:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 8 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:39:

Asn Ile Tyr Ser Glu Glu Leu Arg
1 5

(2) INFORMATION FOR SEQ ID NO:40:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:40:

Thr Ala Leu Ser Glu Lys Arg
1 5

(2) INFORMATION FOR SEQ ID NO:41:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 11 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:41:

Leu Ala Leu Asp Met Glu Ile His Ala Tyr Arg
1 5 10

(2) INFORMATION FOR SEQ ID NO:42:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 8 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:42:

Glu Met Ala Glu Met Arg Ala Arg
1 5

(2) INFORMATION FOR SEQ ID NO:43:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 15 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:43:

Glu Glu Leu Asp Phe Gln Lys Asn Ile Tyr Ser Glu Glu Leu Arg
1 5 10 15

(2) INFORMATION FOR SEQ ID NO:44:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 15 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:44:

Met Gln Gln Gln Leu Asp Glu Tyr Gln Glu Leu Leu Asp Ile Lys
1 5 10 15

(2) INFORMATION FOR SEQ ID NO:45:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 15 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:45:

Glu Glu Leu Asp Phe Gln Lys Asn Ile Tyr Ser Glu Glu Leu Arg
1 5 10 15

(2) INFORMATION FOR SEQ ID NO:46:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 515 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:46:

Thr Ala Leu Ser Glu Lys Arg Thr Leu Glu Gly Glu Leu His Asp Leu
1 5 10 15

Arg Gly Gln Val Ala Lys Leu Glu Ala Ala Leu Gly Glu Ala Lys Lys
20 25 30

Gln Leu Gln Asp Glu Met Leu Arg Val Asp Ala Glu Asn Arg Leu
35 40 45

Gln Thr Met Lys Glu Glu Leu Asp Phe Gln Lys Asn Ile Tyr Ser Glu
50 55 60

Glu Leu Arg Glu Thr Lys Arg Arg His Glu Thr Arg Leu Val Glu Ile
65 70 75 80

Asp Asn Gly Lys Gln Arg Glu Phe Glu Ser Arg Leu Ala Asp Ala Leu
85 90 95

Gln Glu Leu Arg Ala Gln His Glu Asp Gln Val Glu Gln Tyr Lys Lys
100 105 110

Glu Leu Glu Lys Thr Tyr Ser Ala Lys Leu Asp Asn Ala Arg Gln Ser
115 120 125

Ala Glu Arg Asn Ser Asn Leu Val Gly Ala Ala His Glu Glu Leu Gln
130 135 140

Gln Ser Arg Ile Arg Ile Asp Ser Leu Ser Ala Gln Leu Ser Gln Leu
145 150 155 160

Gln Lys Gln Leu Ala Ala Lys Glu Ala Lys Leu Arg Asp Leu Glu Asp
165 170 175

Ser Leu Ala Arg Glu Arg Asp Thr Ser Arg Arg Leu Leu Ala Glu Lys
180 185 190

Glu Arg Glu Met Ala Glu Met Arg Ala Arg Met Gln Gln Gln Leu Asp
195 200 205

Glu Tyr Gln Glu Leu Leu Asp Ile Lys Leu Ala Leu Asp Met Glu Ile
210 215 220

His Ala Tyr Arg Lys Leu Leu Glu Gly Glu Glu Glu Arg Leu Arg Leu
225 230 235 240

Ser Pro Ser Pro Thr Ser Gln Arg Ser Arg Gly Arg Ala Ser Ser His
245 250 255

Ser Ser Gln Thr Gln Gly Gly Gly Ser Val Thr Lys Lys Arg Lys Leu
260 265 270

Glu Ser Thr Glu Ser Arg Ser Ser Phe Ser Gln His Ala Arg Thr Ser
275 280 285

Gly Arg Val Ala Val Glu Glu Val Asp Glu Glu Gly Lys Phe Val Arg
290 295 300

Leu Arg Asn Lys Ser Asn Glu Asp Gln Ser Met Gly Asn Trp Gln Ile
305 310 315 320

Lys Arg Gln Asn Gly Asp Asp Pro Leu Leu Thr Tyr Arg Phe Pro Pro
325 330 335

Lys Phe Thr Leu Lys Ala Gly Gln Val Val Thr Ile Trp Ala Ala Gly
340 345 350

Ala Gly Ala Thr His Ser Pro Pro Thr Asp Leu Val Trp Lys Ala Gln
355 360 365

Asn Thr Trp Gly Cys Gly Asn Ser Leu Arg Thr Ala Leu Ile Asn Ser
370 375 380

Thr Gly Glu Glu Val Ala Met Arg Lys Leu Val Arg Ser Val Thr Val
385 390 395 400

Val Glu Asp Asp Glu Asp Glu Asp Gly Asp Asp Leu Leu His His His
405 410 415

His Gly Ser His Cys Ser Ser Ser Gly Asp Pro Ala Glu Tyr Asn Leu
420 425 430

Arg Ser Arg Thr Val Leu Cys Gly Thr Cys Gly Gln Pro Ala Asp Lys
435 440 445

Ala Ser Ala Ser Gly Ser Gly Ala Gln Val Gly Gly Pro Ile Ser Ser
450 455 460

Gly Ser Ser Ala Ser Ser Val Thr Val Thr Arg Ser Tyr Arg Ser Val
465 470 475 480

Gly Gly Ser Gly Gly Gly Ser Phe Gly Asp Asn Leu Val Thr Arg Ser
485 490 495

Tyr Leu Leu Gly Asn Ser Ser Pro Arg Thr Gln Ser Pro Gln Asn Cys
500 505 510

Ser Ile Met
515

WHAT IS CLAIMED IS:

1. A method for detecting cervical cancer in a human, comprising:
detecting the presence of a cervical cancer-associated protein in a tissue or body fluid sample of the human thereby to indicate the presence of a cervical cancer, wherein the cervical cancer-associated protein is characterized as having a molecular weight of from about 44,900 Daltons to about 69,400 Daltons as determined by standard polyacrylamide gel electrophoresis techniques and an isoelectric point of from about 5.1 to about 6.6 as determined by standard isoelectric focusing techniques, and wherein the protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis.
2. The method of claim 1, wherein said cervical cancer-associated protein is a nuclear matrix protein.
3. The method of claim 1, wherein said detecting step comprises detecting a plurality of cervical cancer-associated proteins.
4. The method of claim 1, wherein said cervical cancer-associated protein has a molecular weight of about 69,400 Daltons and an isoelectric point of about 5.8.
5. The method of claim 1, wherein said cervical cancer-associated protein has a molecular weight of about 53,800 Daltons and an isoelectric point of about 5.5.
6. The method of claim 1, wherein said cervical cancer-associated protein has a molecular weight of about 47,900 Daltons and an isoelectric point of about 5.6.
7. The method of claim 6, wherein a portion of said cervical cancer-associated protein comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 1; SEQ ID NO.: 2; SEQ ID NO.: 3; SEQ ID NO.: 4;

SEQ ID NO.: 5; SEQ ID NO.: 6; SEQ ID NO.: 7; SEQ ID NO.: 8; and SEQ ID NO.: 9.

8. The method of claim 7, wherein said cervical cancer-associated protein comprises an amino acid sequence shown in SEQ ID NO.: 10.
9. The method of claim 6, wherein a portion of said cervical cancer-associated protein comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 11; SEQ ID NO.: 12; SEQ ID NO.: 13; SEQ ID NO.: 14; SEQ ID NO.: 15; SEQ ID NO.: 16; and SEQ ID NO.: 17.
10. The method of claim 9, wherein said cervical cancer-associated protein comprises an amino acid sequence shown in SEQ ID NO.: 18.
11. The method of claim 6, wherein a portion of said cervical cancer-associated protein comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 19; SEQ ID NO.: 20; SEQ ID NO.: 21; SEQ ID NO.: 22; SEQ ID NO.: 23; SEQ ID NO.: 24; and SEQ ID NO.: 25.
12. The method of claim 11, wherein said cervical cancer-associated protein comprises an amino acid sequence shown in SEQ ID NO.: 26.
13. The method of claim 1, wherein said cervical cancer-associated protein has a molecular weight of about 46,000 Daltons and an isoelectric point of about 5.1.
14. The method of claim 1, wherein said cervical cancer-associated protein has a molecular weight of about 44,900 Daltons and an isoelectric point of about 6.6.
15. The method of claim 14, wherein a portion of said cervical cancer-associated protein comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 27; SEQ ID NO.: 28; SEQ ID NO.: 29; SEQ ID NO.: 30; SEQ ID NO.: 31; SEQ ID NO.: 32; and SEQ ID NO.: 33.

16. The method of claim 15, wherein said cervical cancer-associated protein comprises an amino acid sequence shown in SEQ ID NO.: 34.
17. The method of claim 14, wherein a portion of said cervical cancer-associated protein comprises a continuous amino acid sequence selected from the group consisting of: SEQ ID NO.: 35; SEQ ID NO.: 36; SEQ ID NO.: 37; SEQ ID NO.: 38; SEQ ID NO.: 39; SEQ ID NO.: 40; SEQ ID NO.: 41; SEQ ID NO.: 42; SEQ ID NO.: 43; SEQ ID NO.: 44; and SEQ ID NO.: 45.
18. The method of claim 17, wherein said cervical cancer-associated protein comprises an amino acid sequence shown in SEQ ID NO.: 46.
19. The method of claim 1, wherein said method further comprises the steps of:
reacting the sample with a labeled binding moiety capable of specifically binding the cervical cancer-associated protein to form a labeled complex of the binding moiety and the cervical cancer-associated protein; and
detecting the labeled complex thereby to indicate the presence of the cervical cancer.
20. The method of claim 19, wherein the labeled binding moiety comprises a labeled antibody capable of binding an epitope on said cervical cancer-associated protein.
21. The method of claim 20, wherein the antibody is a monoclonal antibody.
22. The method of claim 1, wherein said method, prior to said detecting step, further comprises the step of isolating the cervical cancer-associated proteins from the sample; and
wherein said detecting step comprises,
separating the proteins by two-dimensional gel electrophoresis thereby to produce a two-dimensional gel electrophoresis pattern; and
comparing the gel electrophoresis pattern with a standard.

23. The method of claim 22, wherein the standard is obtained from a data base of electrophoresis patterns.

24. A method for detecting cervical cancer in a human, comprising:
detecting the presence of a nucleic acid molecule in a tissue or body fluid sample of the human thereby to indicate the presence of a cervical carcinoma in the human,

wherein the nucleic acid molecule is selected from the group consisting of:

a nucleic acid molecule comprising a sequence capable of recognizing and being specifically bound by a cervical cancer-associated protein; and

a nucleic acid molecule comprising a sequence encoding a cervical cancer-associated protein,

wherein said cervical cancer-associated protein is characterized as being selected from the group consisting of:

a protein having a molecular weight of about 69,400 Daltons and an isoelectric point of about 5.8;

a protein having a molecular weight of about 53,800 Daltons and an isoelectric point of about 5.5;

a protein having a molecular weight of about 47,900 Daltons and an isoelectric point of about 5.6;

a protein having a molecular weight of about 46,000 Daltons and an isoelectric point of about 5.1; and

a protein having a molecular weight of about 44,900 Daltons and an isoelectric point of about 6.6,

wherein the molecular weight is determined by standard polyacrylamide gel electrophoresis techniques and the isoelectric point is determined by standard isoelectric focusing techniques, and

wherein the cervical cancer-associated protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical

cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis.

25. The method of claim 24, wherein said method comprises reacting the sample with a labeled hybridization probe capable of hybridizing specifically with at least a portion of the nucleic acid molecule.

26. The method of claim 24, wherein the nucleic acid molecule is capable of recognizing and being specifically bound by a protein associated with metastasized cervical cancer; and

wherein the presence of the nucleic acid molecule is detected thereby to indicate the presence of metastasized cervical cancer.

27. The method of claim 24, wherein the cervical cancer-associated protein is a nuclear matrix protein.

28. A kit for detecting the presence of cervical cancer or for evaluating the efficacy of a therapeutic treatment of a cervical cancer, the kit comprising in combination:

a receptacle for receiving a human tissue or body fluid sample from a mammal;

a binding moiety which binds specifically to an epitope on a cervical cancer-associated protein, said protein being characterized as having a molecular weight of from about 44,900 Daltons to about 69,400 Daltons as determined by standard polyacrylamide gel electrophoresis techniques and an isoelectric point of from about 5.1 to about 6.6 as determined by standard isoelectric focusing techniques, and wherein the protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis;

a means for detecting the binding of the binding moiety with the cervical

cancer-associated protein; and
a reference sample.

29. The kit of claim 28, wherein the binding moiety binds specifically to a cervical cancer-associated protein having a molecular weight of about 69,400 Daltons and an isoelectric point of about 5.8.
30. The kit of claim 28, wherein the binding moiety binds specifically to a cervical cancer-associated protein having a molecular weight of about 53,800 Daltons and an isoelectric point of about 5.5.
31. The kit of claim 28, wherein the binding moiety binds specifically to a cervical cancer-associated protein having a molecular weight of about 47,900 Daltons and an isoelectric point of about 5.6.
32. The kit of claim 28, wherein the binding moiety binds specifically to a cervical cancer-associated protein having a molecular weight of about 46,000 Daltons and an isoelectric point of about 5.1.
33. The kit of claim 28, wherein the binding moiety binds specifically to a cervical cancer-associated protein having a molecular weight of about 44,900 Daltons and an isoelectric point of about 6.6.
34. The kit of claim 28, wherein said reference sample is indicative of a normal cervical cell.
35. A method for treating cervical cancer, comprising the step of :
administering to a patient diagnosed as having cervical cancer, a therapeutically-effective amount of a compound which binds specifically to an epitope on a cervical cancer-associated protein thereby to inactivate said protein, said protein being characterized as having a molecular weight of from about 44,900 Daltons to about 69,400 Daltons as determined by standard polyacrylamide gel electrophoresis techniques and an isoelectric point of from about 5.1 to about 6.6 as determined by standard isoelectric

focusing techniques, and wherein the protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis.

36. The method of claim 35, wherein said compound is an antibody.

37. A method for treating cervical cancer, comprising the step of :

administering to a patient diagnosed as having cervical cancer, a therapeutically-effective amount of a compound which reduces the expression of a cervical cancer-associated protein thereby to reduce expression of said protein, said protein being characterized as having a molecular weight of from about 44,900 Daltons to about 69,400 Daltons as determined by standard polyacrylamide gel electrophoresis techniques and an isoelectric point of from about 5.1 to about 6.6 as determined by standard isoelectric focusing techniques, and wherein the protein is further characterized as being a non-chromatin protein which is detectable at a higher level in a human cervical cancer cell than in a normal human cervical cell, as determined by two-dimensional gel electrophoresis.

38. The method of claim 37, wherein said compound is a first nucleic acid sequence complementary to and capable of hybridizing to a second nucleic acid sequence encoding at least a portion of said protein.

ABSTRACT OF THE DISCLOSURE

***"METHODS AND COMPOSITIONS FOR THE
DETECTION OF CERVICAL CANCER"***

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The invention provides a wide range of methods and compositions for detecting and treating cervical cancer in an individual. Specifically, the invention provides target cervical cancer-associated proteins, which permit a rapid detection, preferably before metastases occur, of cervical cancer. The target cervical cancer-associated protein, may be detected, for example, by reacting the sample with a labeled binding moiety, for example, a labeled antibody capable of binding specifically to the protein. The invention also provides kits useful in the detection of cervical cancer in an individual. In addition, the invention provides methods utilizing the cervical cancer-associated proteins either as targets for treating cervical cancer or as indicators for monitoring of the efficacy of such a treatment.

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Fig 1B

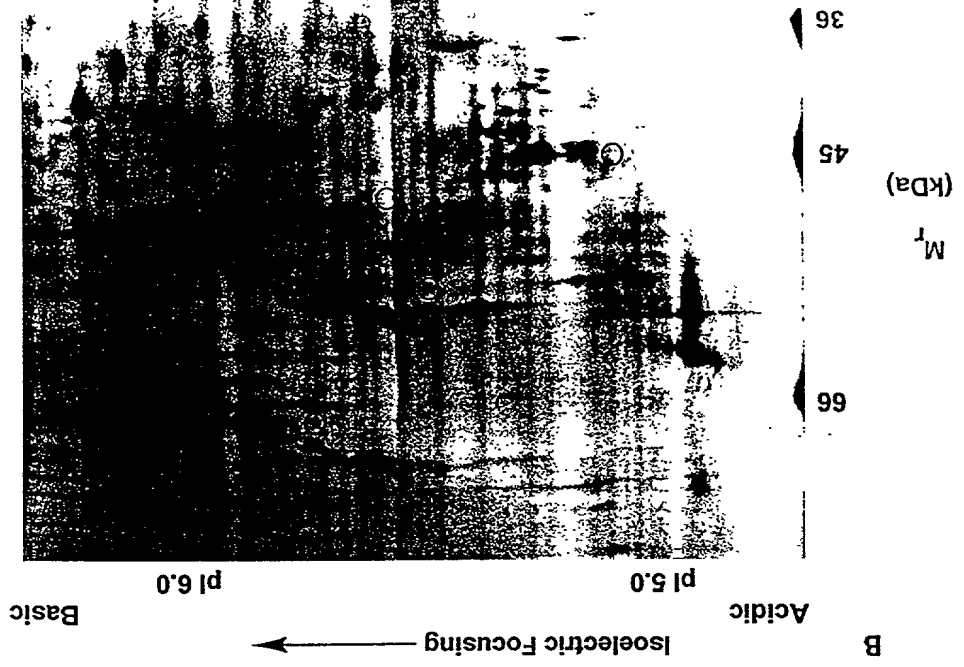
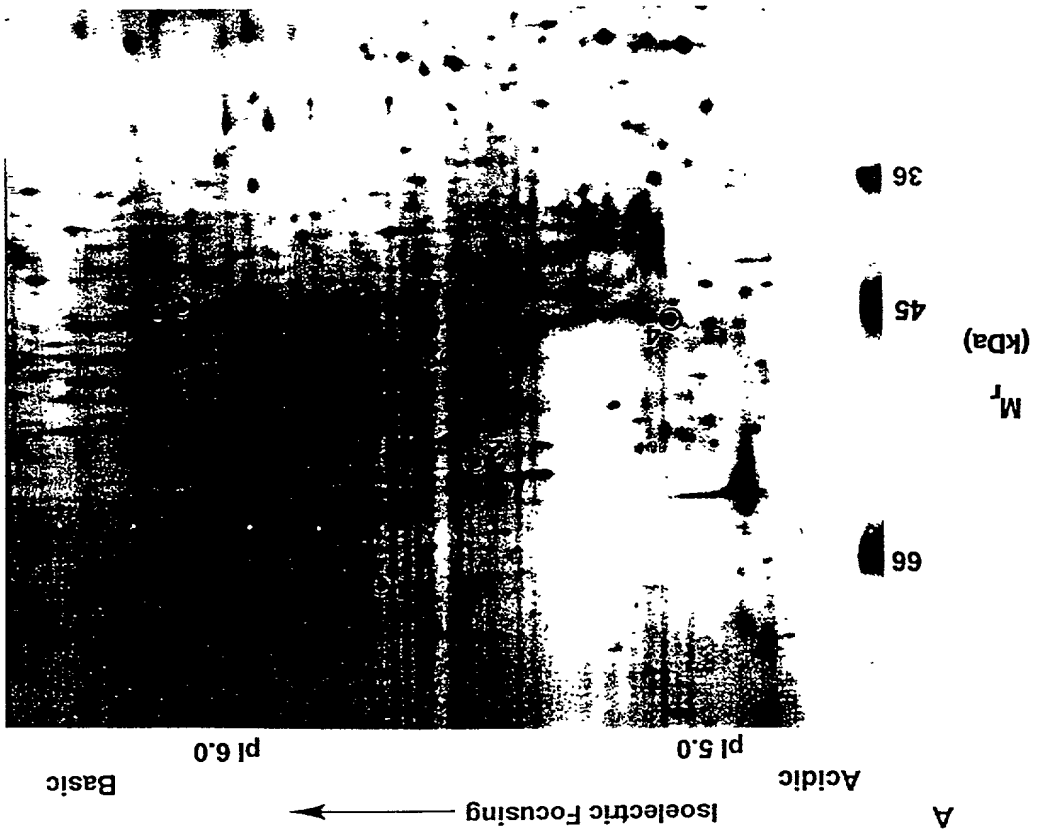


Fig 1A



00315355 00317559

Fig 2B

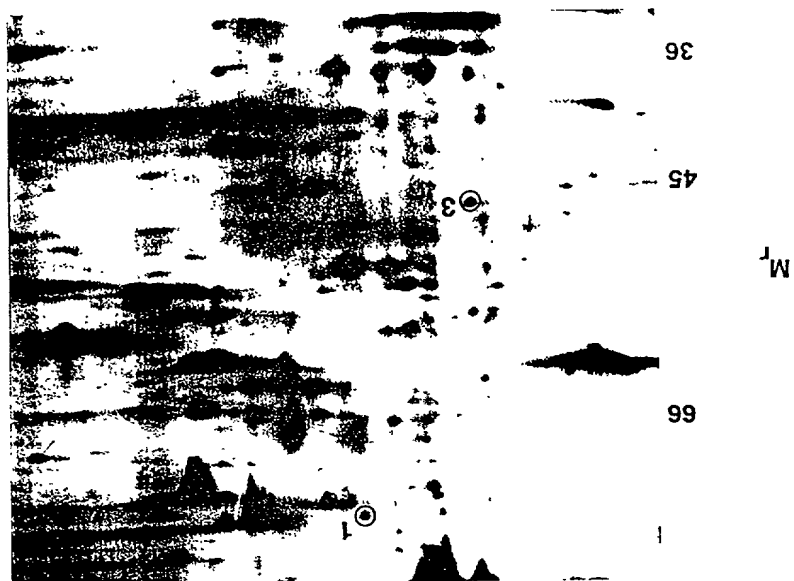
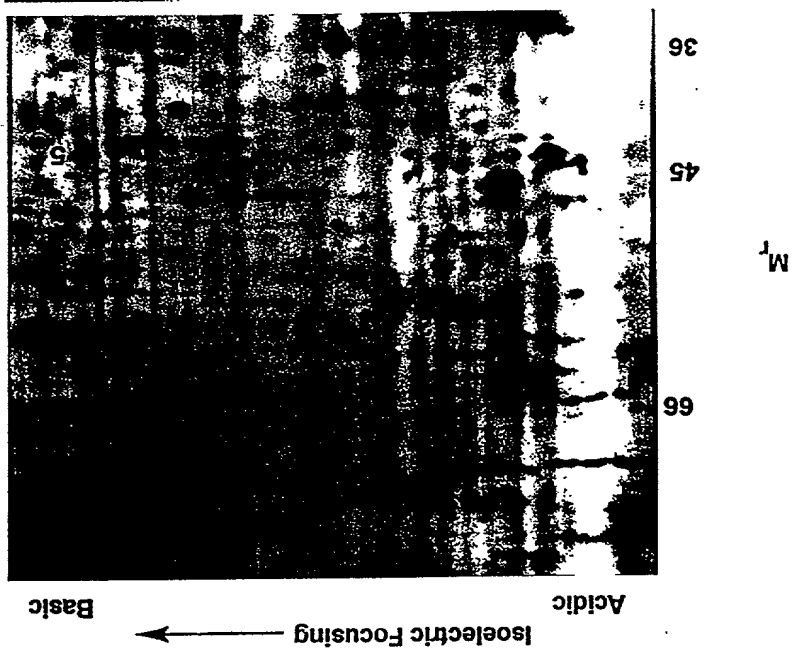


Fig 2A



09315355 053744

EXPRESS MAIL MAILING LABEL

No. EL 280659228US

COPY

PATENT
Atty. Docket No. MTP-023
(8395/27)

**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION**

(Original, Design, National Stage of PCT, Supplemental, Divisional, Continuation or CIP)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type: (check one applicable item below)

- ☒ original
- ☐ design
- ☐ supplemental
- ☐ national stage of PCT

- ☐ divisional
- ☐ continuation
- ☐ continuation-in-part (CIP)

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

"Methods and Compositions for the Detection of Cervical Cancer"

SPECIFICATION IDENTIFICATION

the specification of which (check one):

- ☐ is attached hereto.
- ☒ was filed on August 30, 1996 as Application Serial No. 08/705,660 or
- ☐ Express Mail No., as Serial No. not yet known _____ and was amended on _____ (if applicable).
- ☐ was described and claimed in PCT International _____ Application No. _____ filed on _____ and as amended under PCT Article 19 on _____ (if any).

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to herein.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

Check one:

- ☒ no such applications have been filed.
- ☐ such applications have been filed as follows:

EARLIEST FOREIGN APPLICATION(S), IF ANY FILED WITHIN
12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO
THIS U.S. APPLICATION

Country	Application Number	Date of Filing (mo., day, year)	Priority Claimed Under 37 USC 119
			<input type="checkbox"/> YES NO <input type="checkbox"/>
			<input type="checkbox"/> YES NO <input type="checkbox"/>
			<input type="checkbox"/> YES NO <input type="checkbox"/>

**ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN
12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO
THIS U.S. APPLICATION**

CLAIM FOR BENEFIT OF EARLIER U.S./PCT APPLICATION(S)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

**PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 USC 120:**

U.S. APPLICATIONS	U.S. FILING DATE	STATUS
----- (Application Serial No.)	----- (Filing Date)	----- (Status) (patented, pending, aband.)
----- (Application Serial No.)	----- (Filing Date)	----- (Status) (patented, pending, aband.)

POWER OF ATTORNEY

As a named inventor, I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the United States Patent and Trademark Office connected therewith:

Steven M. Bauer	Reg. No. 31,481
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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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- ☐ Signature for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. Number of pages added _____ .
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